

METROPOLITAN WATER AND SEWERAGE BOARD

TENTH ANNUAL REPORT

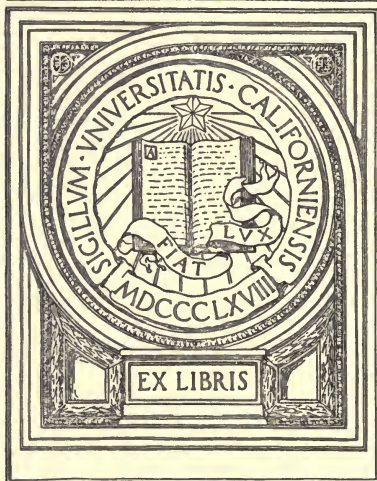
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SCREEN HOUSE OF HIGH-LEVEL SEWER AT NUT ISLAND.

TENTH ANNUAL REPORT

OF THE

METROPOLITAN WATER AND
SEWERAGE BOARD.

FOR THE YEAR 1910.



BOSTON:

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METROPOLITAN WATER AND SEWERAGE BOARD.

To the Honorable the Senate and House of Representatives of the Commonwealth of Massachusetts in General Court assembled.

The Metropolitan Water and Sewerage Board, established under the provisions of chapter 168 of the Acts of the year 1901, has already presented to your Honorable Body an abstract of the account of its doings, receipts, expenditures, disbursements, assets and liabilities for the fiscal year ending on November 30, 1910, and now, in accordance with the provisions of chapter 235 of the Acts of the year 1906, it presents a detailed statement of its doings for the calendar year ending on December 31, 1910, being its

TENTH ANNUAL REPORT

made since the consolidation of the Metropolitan Water Board and the Board of Metropolitan Sewerage Commissioners on March 20, 1901.

I. ORGANIZATION AND ADMINISTRATION.

(1) BOARD, OFFICERS AND EMPLOYÉS.

The term of office of James A. Bailey, Jr., expired on March 21, 1910, and he was reappointed for the three years next succeeding. The membership of the Board has consequently remained as in the preceding year: Henry H. Sprague, chairman, Henry P. Walcott, M.D., and James A. Bailey, Jr. William N. Davenport has continued as secretary and in charge of the auditing department. Alfred F. Bridgman has been the purchasing agent and Miss Alice G. Mason the bookkeeper.

There are also employed in the administrative office a paymaster, an assistant in auditing, two general clerks, three stenographers and clerks, a telephone operator, a messenger, and a janitor with two assistants, one of whom acts as watchman.

George D. Bigelow, with the assistance of Miss Alline E. Marcy, has performed such general conveyancing work and made such further investigation of real estate titles in the different counties as has been called for during the year for the general purposes of the Board.

The consulting engineers of the Board are Hiram F. Mills and Frederic P. Stearns, who are called upon for services when matters arise which require such consideration.

Dexter Brackett, Chief Engineer of the Water Works, has had supervision over the various departments of both construction and maintenance. William E. Foss, as Assistant to the Chief Engineer, has exercised a general charge over engineering work in all departments. The following have also acted under direction of the Chief Engineer: Elliot R. B. Allardice, Superintendent of the Wachusett Department; Charles E. Haberstroh, Superintendent of the Sudbury and Cochituate Works and of the portion of the Weston Aqueduct above the Weston Reservoir; Samuel E. Killam, Superintendent in charge of the Weston Reservoir and the remaining portion of the Weston Aqueduct and of all reservoirs and pipe lines within the Metropolitan District; Arthur E. O'Neil, Superintendent of the several pumping stations; Alfred O. Doane, Division Engineer in charge of engineering work at pumping stations; Benjamin F. Hancox, Assistant in charge of the Drafting Department; Arthur W. Walker, Biologist; William W. Locke, in charge of the sanitary inspection of the watersheds; and William E. Whittaker, Office Assistant.

There has been a slight increase in the number in the engineering force on account of a greater amount of construction work in progress during the past year. The average force employed on construction and maintenance during the year has included, in addition to the Chief Engineer, 4 department superintendents, 2 division engineers, 6 assistant engineers, and 39 others in various engineering capacities and as sanitary inspectors, clerks, stenographers and messengers, the total force numbering 52. The maximum engineering force employed at any one time during the year on both construction and maintenance was 62.

A maintenance force in addition to those engaged in engineering

capacities as above mentioned, numbering upon the average during the year 249, has been required at the pumping stations, upon reservoirs, aqueducts, pipe lines, and upon minor construction work. At the end of the year this force numbered 244.

William M. Brown, Chief Engineer of the Sewerage Works, has had charge of both construction and maintenance. He has been assisted during the year by Frank I. Capen, Frederick D. Smith and Henry T. Stiff, Division Engineers, who have been in supervision of both construction and maintenance departments, by 1 assistant engineer and by 13 others employed in various engineering capacities, and by 2 clerks and stenographers.

The maximum engineering force employed at any one time during the year on construction and maintenance of Sewerage Works was 18.

The regular maintenance force required in addition for the operation of the pumping stations, the care and inspection of the sewers and for other parts of the Sewerage Works, exclusive of the engineers and day-labor forces, has upon the average numbered 148.

The whole regular force of the Sewerage Department at the end of the year numbered 167, of whom the Chief Engineer and 18 assistants and draftsmen were engaged in general upon the works, and, of the remainder, 90 were employed upon the North System and 58 upon the South System.

The day-labor forces under the supervision of the engineers and the immediate direction of the foremen have been employed during the year in connection with the extensions of the Deer Island and East Boston pumping stations and their equipment, in the building of the locker and stable buildings at East Boston, and in the completion of the pipe siphons under Alewife Brook.

The maximum number of men employed upon contracts and upon day-labor construction on the Sewerage Works during the year was for the week ending April 16, when the number amounted to 143.

(2) OFFICES AND BUILDINGS.

The offices of the Board and of the secretary, and of the auditing and conveyancing departments, and the main engineering offices of both Water Works and Sewerage Works, are located in the buildings

numbered 1 and 3 Ashburton Place, at the corner of Somerset Street, in Boston.

The headquarters of the Wachusett Department of the Water Works are at the gate and power house at the Wachusett Dam, in Clinton. The branch office for the Sudbury Department is maintained at South Framingham. Headquarters of the maintenance force of the Water Works for the northern part of the Metropolitan District are maintained in the Glenwood pipe yard in Medford, where there are offices, shops, store-rooms and stables; and the maintenance force for the southern part of the District has headquarters in like buildings at the Chestnut Hill Reservoir.

Branch headquarters of the maintenance and repair forces of the Sewerage Works are maintained for the North Metropolitan System in connection with the East Boston and Deer Island pumping stations, and for the South Metropolitan System at the Ward Street pumping station and at the storage yard at Hough's Neck.

II. METROPOLITAN WATER DISTRICT.

The Metropolitan Water District now comprises the cities of Boston, Chelsea, Everett, Malden, Medford, Melrose, Newton, Quincy and Somerville, and the towns of Arlington, Belmont, Hyde Park, Lexington, Milton, Nahant, Revere, Stoneham, Swampscott, Watertown and Winthrop,—in all 9 cities and 11 towns. The District has an area of 174.8 square miles, no additional municipalities having been admitted into the District during the year. Its population, according to the United States Census taken for April 1, 1910, was 1,070,256. The date upon which calculations for the Water Works are based is July 1, 1910, and the estimate of the population at that date is 1,076,650.

The city of Newton and the town of Hyde Park, though belonging to the District, have not made application to take water from the Metropolitan sources.

III. METROPOLITAN WATER WORKS—CONSTRUCTION.

The total amount expended for the construction and acquisition of the Metropolitan Water Works since the passage of the Metropolitan Water Act in the year 1895 has been \$41,546,929.56.

During the past year the amount of construction work has been considerably in excess of that of either of the previous four years. The total amount expended during the calendar year on account of the construction and acquisition of works has been \$502,624.92. There has been expended on account of the Wachusett Reservoir, principally in settlement of the claim for the taking of the St. John's Catholic Cemetery, the sum of \$35,955.26; the sum of \$275,381.04 in the laying of the new 60-inch main for bringing the supply of water from the Weston Aqueduct into the Metropolitan District; the sum of \$10,842.71 in the laying of a 16-inch force main in Arlington for the purpose of connecting the pumping station with the standpipe in that town; the sum of \$71,320.04 for the reinforcement of the supply of East Boston; the sum of \$22,577.50 for the northern high service, largely in the laying of a new 16-inch main in Lynn to reinforce the supply of the town of Swampscott; the sum of \$60,892.44 on account of the new pumping engine which is to be installed at Chestnut Hill for the use of the southern high-service district; and the remainder, the sum of \$25,655.93, has been expended for stock, other minor works and administration expenses.

(1) WACHUSETT DAM AND RESERVOIR.

(a) *Power Plant.*

In accordance with the recommendations made by the Board the Legislature of the year 1910 passed a statute providing that the property held by the Metropolitan Water and Sewerage Board in the town of Clinton outside of the dam and dike, used in the generation and sale of electricity for power or for manufacturing purposes, shall be assessed on a valuation of \$125,000 in any year in which any power is generated and sold.

Before proceeding upon the construction of the power plant it had seemed necessary, inasmuch as the local tax upon such a plant would become so considerable an element in the cost of the power to be disposed of, that the valuation for taxation should be permanently established. The statute of 1910 further provided that the Board, before making a contract for the sale of the electricity, should make public request for proposals for its purchase. The

Board accordingly, after the passage of the act, proceeded to ask for proposals for the purchase of the electricity which might be generated, and as a result a five-year contract was made with the Connecticut River Transmission Company. It was provided in the contract that the Board should install a plant sufficiently large to develop the electric energy available from the fall of the water at the Wachusett Dam, and should also build a transmission line to connect with the transmission line erected by the company for the purpose of making a connection with the Lancaster Mills. The contract recognized that the amount of electric energy available from time to time during the year would be dependent upon the quantity of water which should be introduced into the aqueduct, and that this supply would be increased or diminished and at certain portions of the year wholly suspended, as might be necessary for the purposes of conserving the water supply of the Metropolitan District and utilizing the water supplied from sources nearer Boston.

The Board having made a contract for the sale of power proceeded at once to make plans and specifications for the installation of the necessary machinery in the power house at the foot of the dam. Proposals were invited from the leading hydraulic and electric manufacturing companies, and as a result a contract for installing the machinery required for the development of the power was made with the S. Morgan Smith Company of York, Pa., for both the hydraulic turbines and electric generators, it being understood that the electrical equipment would be furnished under a sub-contract with the Westinghouse Electric & Manufacturing Company of Pittsburg, Pa. Work under the contract has already been begun, and its terms provide that it shall be so far completed that power can be furnished to the Transmission Company by July 1, 1911.

(b) St. John's Catholic Cemetery.

The Board was enabled on May last to bring about a final settlement under the agreement which had been made in the year 1898 with the Roman Catholic Bishop of the Diocese of Springfield and the St. John's Catholic Cemetery Association, by which the land acquired for the old cemetery in Clinton was taken for the Wachusett Reservoir and the bodies removed to a new cemetery site in Lancaster, purchased by the Board for the purposes of the Association.

A deed was received from the Bishop of the Diocese conveying the title to the land, and the Bishop and the Cemetery Association united in a release to the Commonwealth of all claims for damages by reason of the taking. The Board executed a deed to the Association of the cemetery lands in Lancaster and paid over to the Association the sum of \$32,096.83, the balance which had long remained payable under the terms of the agreement.

(2) IMPROVEMENT OF THE WATERSHEDS.

No large work has been undertaken during the past year for the improvement of the Wachusett watershed. Two small parcels of land, one of which afforded a menace to a brook emptying into the Wachusett Reservoir, and the other to the reservoir itself, have been purchased for the better protection of the water. A small parcel in Marlborough was purchased for the protection of the Sudbury Reservoir, and four small strips of land along the shore of Lake Cochituate were also acquired to increase the marginal width of the lake.

The construction of a system for diverting the surface drainage of the village of Cochituate from the lake has been carried on by the maintenance department.

It has continued to be the policy of the Board to take such action as from time to time seems necessary in order to suppress the dangers which threaten the purity of the water.

(3) DISTRIBUTION SYSTEM.

(a) *New Weston Aqueduct Supply Main.*

The work of laying the 60-inch supply main which is to afford an additional connection between the Weston Aqueduct and the present mains near the Chestnut Hill Reservoir, and which was begun in the preceding year, has been prosecuted, and of the entire length of about 34,650 feet, 17,584 feet of iron pipe have been laid and 2,042 feet of tunnel have been excavated. The new main is located for the larger portion of the distance through Commonwealth Avenue, beginning near the Charles River in Newton and extending to the junction of Beacon Street and Chestnut Hill Avenue in Boston. It is contemplated at present to construct but a little more than 20,000 feet, being the lower portion ending near the Chestnut

Hill Reservoir, as it is deemed possible, owing to the reduction in the consumption of water in the District, to defer the completion of the remaining portion for the present. There remain principally to be completed in the part under immediate construction the masonry lining of the tunnel in Newton and the laying of 80-inch steel pipes at either end to make connection with the other portions of the line. The tunnel and connecting steel pipes have been made of a sufficient capacity to provide for another pipe line from the Weston Aqueduct in the future. The section under present construction will be brought to completion about the middle of the coming year.

(b) New Force Main in Arlington.

A 16-inch force main was laid during the year from Massachusetts Avenue in Arlington up to the standpipe on Arlington Heights, a distance of 3,750 feet. This main was laid in order to improve and make adequate the supply of the high-service districts in Arlington and Lexington and has been completed at a total cost of \$10,842.71, inclusive of engineering.

(c) New Supply Main for East Boston.

The Legislature of last year authorized the laying of an additional main in order to improve and render more secure the water supply of the East Boston district. For this purpose the Board has proceeded during the year to lay a main, in part 30 inches and in part 36 inches in diameter, from a connection with the Metropolitan main in Chelsea for a distance of about 3,800 feet to a point near the Chelsea Street Bridge, and thence through a tunnel for a distance of about 400 feet under Chelsea Creek to the East Boston side. The tunnel through which the pipe is laid has been constructed with an inner diameter of 6 feet 10 inches at a depth of about 50 feet below the surface of the creek at high water. The construction of the tunnel required the introduction of compressed air, and on account of the difficulty of the work it was determined to proceed by day labor. The tunnel and the laying of the pipe have been nearly completed and it is expected that water will be introduced through the new main early in the coming year.

(d) New 16-inch Main for Swampscott Water Supply.

As a part of the work which is deemed necessary in order to furnish a proper water supply to the town of Swampscott, a new 16-inch main has been laid through Ocean and New Ocean streets in Lynn to the Swampscott line. The entire cost of this work was \$14,009.70.

(e) New Pumping Engine at Chestnut Hill.

A contract for a new pumping engine having a capacity to pump 40,000,000 gallons per day was made in the year 1909. During the past year the parts of the engine have been received at the Chestnut Hill pumping station, where work of erection has been in progress as well as the construction of foundations for the engine and boilers. Although the engine is to be used for the supply of the southern high-service district it is located in the low-service pumping station. It is expected that the new engine will be placed in service early in the coming year.

(4) ACQUISITION OF LANDS AND SETTLEMENTS FOR DAMAGES.

During the past year the Board has further acquired in fee by purchase 62.706 acres of land, and by taking 0.624 of an acre. It has in addition acquired rights or easements by purchase in 0.133 of an acre, and by taking in 3.42 acres. The total acquisitions of land have thus amounted to 66.883 acres.

The lands acquired embraced three tracts, containing 62.159 acres in West Boylston for the protection of the Wachusett water supply; four parcels in Natick amounting to 0.547 of an acre for the protection of Lake Cochituate; a parcel of land containing 0.516 of an acre in Marlborough for the protection of the Sudbury Reservoir; several parcels in Newton having an aggregate of 3.202 acres for the 60-inch pipe line; a parcel of 0.401 of an acre in Arlington for the extension of the high service; and two parcels in Chelsea and East Boston of 0.0299 of an acre and 0.0325 of an acre, respectively, for the construction of the East Boston tunnel and pipe line.

Under the settlement which was made with the Roman Catholic Bishop of Springfield, a deed was received and a taking was made of the land formerly included in the St. John's Catholic Cemetery in Clinton, amounting to 26.39 acres, although this land had long been in possession of the Board.

The Board has conveyed away, as lands no longer required for its purposes, the lot in Clinton which was formerly occupied for offices for the sum of \$3,950; and also a parcel situated between Mystic Street and Old Mystic Street in Arlington for the sum of \$1,947. The settlement for the St. John's Catholic Cemetery lands included the release to the St. John's Catholic Cemetery Association of the parcel of land in Lancaster which had been acquired by the Board for the removal of bodies and held for cemetery purposes.

The settlements made during the past year on account of lands purchased and taken have numbered 13. The amount paid, including the balance of \$32,096.83 paid in the settlement for the St. John's Catholic Cemetery lands, was \$38,507.84. All these settlements have been effected by voluntary agreement.

There have been 9 takings of land for the Metropolitan Water Works, involving the taking in fee of 418.748 acres and easements and rights in 3.424 acres. The takings of lands in Sterling and West Boylston, and in Natick and Framingham, were of lands to which title by deed had previously been acquired. The following is a list of the takings made during the year for Water Works: —

Takings for Metropolitan Water Works for the Year 1910.

No.	LOCATION AND DESCRIPTION.	Former Owner.	Recorded.	Purpose of Taking.
128	Newton, — from Commonwealth Avenue northeasterly across Grant Avenue and Ward Street to Cochituate Aqueduct. Area, fee in 0.108 acre. Easements in 2.381 acres. Rights in 0.580 acre.	John Ward <i>et al.</i> , heirs of Francis Pettee, heirs of George K. Ward, William F. Harbach <i>et al.</i> , Nehemiah W. Rice <i>et al.</i> , Caroline R. Braman and Charles G. Rice.	1910. May 12.	Weston Aqueduct supply mains.
129	Arlington, — from Robbins Road to Park Avenue. Area, easements in 0.401 acre.	Within location of streets or private ways.	May 12.	Northern extra high-service pipe lines.
130	Sterling, — the John Gates farm and adjacent parcels on West Waushacum Pond. Area, fee in 230.71 acres.	Willie R. Mitchell <i>et al.</i> , Charles H. Baldwin and West Boylston Manufacturing Company.	May 23.	Improvement of Wachusett watershed.
131	Clinton, — the St. John's Catholic Cemetery. Area, fee in 26.39 acres.	The Roman Catholic Bishop of Springfield.	July 14.	Wachusett Reservoir.
132	Chelsea and East Boston, — parcels near Chelsea Street Bridge on Eastern Avenue, Chelsea, and Chelsea Street, East Boston. Area, easements in 0.0299 acre, Chelsea, and 0.0325 acre and temporary rights in 0.0131 acre, East Boston.	Albert D. Bosson <i>et al.</i> , and The Standard Oil Company of New York.	Aug. 13.	Low-service pipe lines.
133	Marlborough, — on an arm of Sudbury Reservoir, both sides of Mowry Brook. Area, fee in 0.516 acre.	The widow and heirs of Philip Mowry.	Sept. 1.	Sudbury Reservoir.

Takings for Metropolitan Water Works for the Year 1910 — Concluded.

No.	LOCATION AND DESCRIPTION.	Former Owner.	Recorded.	Purpose of Taking.
134	Natick and Framingham, — outlying and marginal parcels on and near Speene Street and West Central Street, Natick, and on Pleasant Street, Framingham. Area, fee in 6.85 acres.	Westborough Savings Bank, Rufus G. Bayer <i>et al.</i> , D. J. Ferguson and Rebecca J. Belknap.	Nov. 1.	Improvement of Sudbury and Cochituate watersheds.
135	West Boylston and Sterling, — outlying parcels, Crescent Street, West Boylston, North Main Street, Oakdale, Waushacum Walk and West Waushacum Pond, Sterling. Area, fee in 16.554 acres.	Mary J. Warner, Walter B. Sawyer, Carrie E. Adams, Willie R. Mitchell <i>et al.</i> , and Elmer E. Towle <i>et al.</i>	Nov. 1.	Improvement of Wachusett watershed.
136	Sterling, — on East or West Waushacum ponds. Area, fee in 137.62 acres.	West Boylston Manufacturing Company, Frank L. Wilder <i>et al.</i> , Willie R. Mitchell and Agnes L. Benfield.	Dec. 21.	Improvement of Wachusett watershed.

IV. WATER WORKS — MAINTENANCE.

(1) OPERATION OF WORKS.

The maintenance of the Metropolitan Water Works has required the expenditure of \$414,121.52 during the past calendar year. There is involved the maintenance and operation of the various storage and distributing reservoirs and standpipes, aqueducts, pumping stations, main pipe lines, filter-beds, pipe yards, gate-houses, siphon and terminal chambers, dwelling houses for attendants, and buildings and other structures used or held for different operating purposes.

(2) STORAGE RESERVOIRS.

There are maintained the following reservoirs for the collection and storage of water in the various watersheds which serve as sources of supply for the distribution to the different municipalities: —

Cochituate watershed: —

Lake Cochituate, including Dudley Pond,	Capacity in Gallons. 2,242,400,000
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Sudbury watershed: —

Sudbury Reservoir,	7,253,500,000
Framingham Reservoir No. 1,	287,500,000
Framingham Reservoir No. 2,	529,900,000
Framingham Reservoir No. 3,	1,180,000,000
Ashland Reservoir,	1,416,400,000
Hopkinton Reservoir,	1,520,900,000
Whitehall Reservoir,	1,256,900,000
Farm Pond,	167,500,000

Wachusett watershed: —

Wachusett Reservoir,	64,968,000,000
Total,	80,823,000,000

The full capacity of the reservoirs of 80,823,000,000 gallons was not reached during the year. The total quantity in storage at the beginning of the year was 62,101,500,000 gallons. The maximum quantity of 77,826,500,000 gallons was reached on May 10. During the latter half of the year there was a continual loss of storage, and at the end of the year the total quantity was 59,327,000,000 gallons, a net loss from the beginning of the year of 2,774,000,000 gallons.

The Wachusett Reservoir was not filled to high-water mark at any time during the year. At the beginning of the year the water was 12.91 feet below this mark, and reached its highest point on May 1, when its level was but 0.74 of a foot below high-water mark. There was a gradual loss during the latter part of the year, and at the end the reservoir was 15.65 feet below the high-water level and contained 45,610,400,000 gallons, showing a net loss during the year of more than 3,000,000,000 gallons.

The chief work which has been required in connection with the Wachusett Reservoir has been occasioned by the washing away of the soil at exposed places along the shore through the action of the waves. For an area along the reservoir nearly a mile in length it has been found necessary further to strip the soil in order to keep a proper marginal width.

In connection with the discharge of water from the reservoir into the river below, as required by the statute, a fountain has been installed in the pool, which has added an attractive feature to the grounds.

All the water taken from the Wachusett Reservoir was carried into the Sudbury Reservoir and thence in large part through Framingham Reservoir No. 3 into the Metropolitan District, and both these latter reservoirs were kept full or nearly full during the year.

It being deemed preferable to draw the water from the Wachusett supply, the other Framingham reservoirs and the Ashland, Hopkinton and Whitehall reservoirs, having independent sources, were not drawn upon during the year.

Water has been drawn from Farm Pond, through a filter gallery alongside of the pond, by the town of Framingham for the larger part of its supply, but a comparatively small portion has also been taken by the town directly from the Sudbury Aqueduct.

Several small strips of land along the shore of Lake Cochituate



IMPROVEMENT OF LAKE COCHITUATE—APPEARANCE SOUTH OF COUNTY ROAD
IN FRAMINGHAM BEFORE AND AFTER DRAINAGE WORK.

have been purchased during the year in order to add to the width of the marginal land under the control of the Board, and better to protect the water of the lake from pollution.

The principal measure, however, which has been taken for the protection of the water supply has been the construction of a system of surface drainage, which is to take the surface water from the village of Cochituate now flowing into Snake Brook, a tributary of the lake, and divert it into Bannister's Brook, which flows into the Sudbury River and outside of the Cochituate watershed. A large vitrified pipe is laid from Main Street in Cochituate village to the junction with Hammond's Brook, and thence a concrete covered drain 36 inches by 33 inches in dimensions has been constructed substantially along the County Road for a distance of 3,454 feet to a point beyond the town line of Natick, whence an open channel, with a bottom width of 12 inches, has been built for a distance of 5,958 feet, following an old drain to Bannister's Brook, and through the brook to an old mill-pond north of the County Road and west of Speene Street in Framingham.

The contract for this undertaking had been almost completed at the end of the year. An appropriation amounting to \$36,000, chargeable to maintenance, had been made for this improvement. The sum of \$26,883.44 has been so far expended, but the total cost will come considerably within the appropriation.

The prosecution of the work required the lowering of the water of the lake for a considerable period, and for this reason and on account of the excavation of the tunnel in Newton for the new 60-inch pipe in close proximity to the Cochituate Aqueduct, it has been deemed best not to draw water from Lake Cochituate, as has been usually done during a portion of the year.

(3) AQUEDUCTS.

Nearly all the water consumed in the Metropolitan District was brought from the Wachusett Reservoir, and consequently was carried through the Wachusett Aqueduct into the Sudbury Reservoir. The average number of gallons per day thus carried through the Wachusett Aqueduct was 103,146,200. The Wachusett Aqueduct was in operation during 340 days in the year.

From the Sudbury Reservoir water was discharged into Framing-

ham Reservoir No. 3, and thence an average of 85,033,000 gallons per day was drawn through the Sudbury Aqueduct to the Chestnut Hill Reservoir. This aqueduct was in continuous service during the entire year.

The Weston Aqueduct was also continuously operated during the year, and the daily average flow was 28,974,000 gallons. This water was taken directly from the Sudbury Reservoir.

No water was drawn through the Cochituate Aqueduct for the use of the District during the year, but the aqueduct was kept in condition ready for use if called upon at any time.

(4) DISTRIBUTING RESERVOIRS AND STANDPIPES.

The distributing reservoirs and standpipes located in different parts of the Metropolitan District have a total capacity of 2,381,230,000 gallons. These reservoirs are kept substantially full during the year, not only as a protection and relief in cases of accident or emergency, but also in order to secure a proper distribution of the water throughout the District. They are as follows:—

	Capacity in Gallons.
Spot Pond,	1,791,700,000
Chestnut Hill Reservoir,	300,000,000
Weston Reservoir,	200,000,000
Fells Reservoir,	41,400,000
Mystic Reservoir,	26,200,000
Waban Hill Reservoir,	13,500,000
Forbes Hill Reservoir,	5,100,000
Bear Hill Reservoir,	2,450,000
Arlington Standpipe,	550,000
Forbes Hill Standpipe,	330,000
Total,	2,381,230,000

(5) PUMPING STATIONS.

While about one-quarter of the water introduced into the Metropolitan District has been supplied by gravity, the remainder, or three-quarters of the whole, has been lifted by pumping at the two Chestnut Hill stations in order that it may be delivered in the various portions of the District at the requisite pressure. A portion

of the water is necessarily lifted a second time for the supply of the higher sections.

The following are the several pumping stations:—

	Number of Engines.	Maximum Contract Capacity per Day (Gallons).	Lift (Feet).
Chestnut Hill High-service Station, . .	4 ¹	66,000,000	138
Chestnut Hill Low-service Station, . .	3	105,000,000	60
Spot Pond Station,	2	30,000,000	125
Arlington Station,	2	3,000,000	290
West Roxbury Station,	3	3,750,000	140

¹ The new pumping engine in process of erection for the high service, to be located in the low-service station, will have a maximum contract capacity of 40,000,000 gallons per day, with a lift of 130 feet.

An average of 84,654,000 gallons was daily pumped from the two Chestnut Hill stations, and in the other stations an average of 8,995,000 gallons was daily pumped.

The total cost of operating all the stations during the year was \$101,996.34, or \$2.99 per million gallons pumped. Of this total, \$61,933.82 was expended for labor and \$34,332.78 for fuel.

The total amount of coal purchased during the year was 9,693.63 gross tons, of which 6,941.47 tons were bituminous, 314.53 tons anthracite, 2,101.77 tons buckwheat anthracite, and 335.86 tons anthracite screenings. The average cost of bituminous coal delivered in the bins at the various stations varied from \$3.85 to \$4.82; the average cost of anthracite coal was \$4.91; the cost of buckwheat varied from \$2.59 to \$2.76, and of anthracite screenings from \$2.50 to \$2.68.

All the bituminous coals purchased are subjected on delivery to strict tests as to their heating power and as to the amount of moisture contained, and it is provided in the contracts for furnishing the coal that a deduction shall be made when the coal falls below a fixed standard, and at the same time the price is increased if it is found to be superior to the standard required.

(6) PIPE LINES.

There has been during the past year an increase in the length of main pipe lines owned and operated by the Metropolitan Water and Sewerage Board of 4.49 miles, the total length of the mains now owned and in operation being 97.02 miles. The Metropolitan mains are operated in connection with local mains 4 inches and more in diameter, by which the water is distributed to the various municipalities of the District, and which have a length of 1,633.37 miles.

The principal addition to the mains has been the laying of about $2\frac{1}{3}$ miles of the 60-inch supply main from the Weston Aqueduct, but the new line for the improvement of the East Boston supply, the line in Lynn for the reinforcement of the Swampscott supply, and the line between the pumping station and standpipe in Arlington, have added considerable to the total mileage.

Several changes in mains have been required during the past year, largely on account of construction of other public works.

The construction of the subway station at Harvard Square in Cambridge by the Boston Elevated Railway Company compelled a change in the 48-inch main running through Boylston Street and Massachusetts Avenue for a distance of about 650 feet. For a portion of the distance three 24-inch mains were substituted for the original 48-inch main. This work involved much difficulty, and was performed in part by the Board at the expense of the company and in part by the Boston Elevated Railway Company itself.

Other changes found necessary have been the lowering of the 48-inch main in Reservoir Lane in Brookline near the Chestnut Hill high-service pumping station for a distance of 275 feet, in order to permit the construction of Crafts Road across the lane; the lowering of the pipe under the Mystic River between Medford and Arlington for a distance of 130 feet to permit the deepening of the channel by the Metropolitan Park Commission; and a relocation of the main in Morton Street in West Roxbury in order to conform to the new location of a branch of the Stony Brook conduit made by the city of Boston.

It has also been necessary to relay a portion of the 48-inch main in Boylston Street, Cambridge, on account of the destructive effects of electrolysis upon the pipes.



SUBSTITUTING THREE 24-INCH PIPES FOR 48-INCH PIPE IN MAIN AT HARVARD SQUARE, CAMBRIDGE.

No breaks in the mains have occurred during the year, but there have been discovered and repaired 45 leaks in pipe lines. Several of the leaks occurred in the pipes laid under the Charles and Mystic rivers, and in the repairs resort was necessarily had to dredging machines and divers. The larger part of the leaks occurred at leaded joints, and were in many cases due to settlement of the pipes on account of adjacent excavations made in the prosecution of other public work.

The Venturi and other meters, by which the water delivered to the various municipalities is measured, have been the efficient means of detecting leaks in the local systems which failed to be discovered by the authorities themselves. Two notable leaks, in each case amounting to about 1,000,000 gallons per day, were, through the indications of the meters, found in Medford and in Brighton, the water escaping in one case into the river and in the other into a sewer.

(7) CLINTON SEWERAGE WORKS.

The Clinton Sewerage Works have been operated under the requirements of the Metropolitan Water Act in order to dispose of the sewage of the town, which had formerly been discharged into the South Branch of the Nashua River before the principal portion of the water was diverted for the Metropolitan supply.

About 829,000 gallons of sewage per day have been pumped upon the filter-beds, at a total cost of \$3,545.92, or of \$11.72 per million gallons pumped.

A considerable improvement in the efficiency of the filter-beds has been effected by continuing the work previously begun of constructing underdrains and of placing distributing channels over the surfaces of the beds.

In addition to the 29 beds before constructed, 2 new beds have been built during the past year in a more isolated location in order to receive the sludge from the settling basins, into which the sewage is directly pumped.

The measures which have been taken have brought about a decided improvement in the character of the effluent discharges. The sludge which has gathered has been used as fertilizer for the grass lands in the vicinity of the Wachusett Dam and the North Dike.

The sum of \$3,353.42 was expended in the required maintenance of the filter-beds, and an additional sum of \$4,895.61 was spent upon the improvements.

(8) PROTECTION OF THE WATER SUPPLY.

Various means have been employed in connection with the maintenance of the works in order to preserve the purity of the water supplied to the District and to protect it from pollution.

(a) *Pegan Brook Filtration Works.*

In the work of protecting the waters of Lake Cochituate about 577,550 gallons per day of the surface drainage which comes from the more thickly settled portions of the town of Natick have been collected and pumped upon filter-beds before the water of the brooks intercepted is allowed to enter the lake. The cost of maintaining and operating the pumping station and the filter-beds has been \$2,606.47, or \$12.77 per million gallons treated.

(b) *Marlborough Brook Filter-beds.*

The surface water from the thickly settled portions of the city of Marlborough, flowing into Marlborough Brook, has been diverted into a settling basin and thence into filter-beds, before it has been admitted into the Sudbury Reservoir. During a few days only in the year has diluted sewage overflowed from the Marlborough sewer mains into the brook. The filters have been sufficient to dispose of all the waters of the brook except upon two days of heavy storm.

(c) *Sterling Filter-beds.*

The filter-beds constructed on the brook which flows through the centre of the town of Sterling and into Lake Waushacum have been in continuous and successful operation through the year. The smaller filter-beds at Sterling Junction, which were built to intercept the sewage of the summer cottages and prevent the pollution of the Waushacum Brook, a direct tributary of the Wachusett Reservoir, have been kept in operation during the summer season.

(d) Drainage Ditches.

The ditches which have been built for an aggregate length of 36.36 miles, in order to provide a quick drainage of the principal swamps upon the several watersheds and to prevent the discoloration and deterioration of the water flowing from them into the various storage reservoirs, require from year to year not only regular oversight but many repairs and renewals. These have involved a considerable expense, amounting to \$2,315.65, but the result has been satisfactory in the improvement of the quality of the water.

(e) Sanitary Inspection and Policing.

A sanitary inspector, William W. Locke, C.E., and one assistant have been continuously engaged, and others to the maximum of 15 in number have been employed for various periods during the year, in the inspection of the watersheds, not only for the purpose of remedying minor sources of pollution but also for the more general protection from injury of the property of the Commonwealth.

The sanitary inspectors have examined 1,481 premises on the Wachusett watershed and 7,226 premises on the Sudbury and Cochituate watersheds with reference to cesspools, privy, sink and barn drainage, manufacturing wastes and sewer connections.

During the year a census has been made, showing in the different sections of the watersheds the permanent and summer populations, the number of dwellings occupied permanently and in the summer, the population unconnected with sewers, and the numbers of domestic animals which are kept. The tables, which are given in the report of the Chief Engineer of Water Works, indicate a decided improvement in the sanitary condition of the watersheds during the last five years, and show that the number of premises deemed "unsatisfactory," that is, those from which trouble may possibly arise under unfavorable circumstances, have been greatly reduced.

These tables show that upon the Wachusett watershed the total permanent population is 44.7 per square mile of area, and that on the Sudbury and Cochituate watersheds the population in dwellings not connected with sewers is respectively 129.7 and 260.4 per square mile.

There were 3 cases of typhoid fever reported on the Wachusett

watershed and 130 cases upon the Sudbury and Cochituate watersheds. All these cases were carefully watched, and measures, which were entirely successful, were adopted to prevent the pollution of the water supply.

A more general patrol for the protection of the water supply has been required during more or less of the year. Three officers are regularly employed in the policing of the Wachusett and Sudbury systems, though other duties are assigned them in connection with this employment. Two watchmen were employed about Lake Cochituate in the summer and camping season and while a large gang of laborers was engaged on public works in the vicinity. The large number of persons visiting the grounds about the Chestnut Hill reservoirs and Spot Pond in the summer season has made it necessary, for the more effective protection both of the water supply and of the property of the Commonwealth, to employ patrolmen more or less on Saturdays, Sundays and holidays, and for the purpose men have generally been detailed from other duties. These various efforts have been successful in preventing any serious injury.

(f) Laboratory Examinations.

Weekly and monthly examinations are made in the laboratory of the Board to ascertain the number of organisms and bacteria contained, and to determine the color, taste, odor and turbidity of the water of the various reservoirs and of the various tributaries which feed the larger sources from which the supply is taken. There have thus been made 2,377 microscopical and 961 bacterial examinations during the year. Samples are also sent for monthly and bi-monthly chemical examination at the laboratory of the State Board of Health. These examinations not only enable the quick detection of objectionable organisms or other substances in the water, but make it possible to draw the water for immediate use in a large measure from sources where the most favorable conditions exist.

(9) QUALITY OF THE WATER.

The water drawn from the Wachusett and Sudbury reservoirs, which have furnished almost the entire supply during the year, has been peculiarly free from objectionable organisms. Other disturbing elements have also been lacking, and the water furnished the District has been of exceptionally good quality.

(10) FORESTRY AND MOTH SUPPRESSION.

The lands under the custody of the Board comprise about 10,000 acres, and the larger part of these are embraced in the margins surrounding the great reservoirs, particularly the Wachusett Reservoir. For the better protection of the water of the reservoirs it has been the policy of the Board to plant with trees the larger part of the territory which was not already wooded. The original nurseries, the Lamson and Flagg nurseries, maintained on the north and south sides of the Wachusett Reservoir, will gradually give way to a single new nursery which has been started on Waushacum Street in Oakdale.

The work about the Wachusett Reservoir during the past year has consisted principally in replanting sections along the immediate margins in order to supply the places of trees which had died, the thinning out of portions of the old woodlands, the improvement of forest roads and the planting of trees along the highways.

A considerable number of arbor vitæ trees have been set out on the shores and lands about the Sudbury Reservoir, white pines have been planted on portions of the shore about Lake Cochituate and along the Sudbury Aqueduct, and other trees have been set out along the Weston Aqueduct and at Spot Pond.

The ravages of the gypsy and brown-tail moths, the elm-leaf beetle and the pine-tree weevil have continued on various parts of the lands under the custody of the Board, and the sum of \$6,010.21 has been spent in the efforts to suppress them, an amount about \$2,000 less than that called for in the preceding year.

The moths have been encountered, though in somewhat less numbers, at Spot Pond, at the Chestnut Hill Reservoir, and also at the Sudbury and Weston reservoirs, and along portions of the aqueducts. A few moths have been discovered the past year in the vicinity of the Wachusett Reservoir. At the Weston Reservoir the elm-leaf beetle has been more than ever prevalent and destructive. At the Wachusett Reservoir the pine-tree weevil infested the young pines more than in previous years, and it was also alike destructive at the Sudbury Reservoir.

(11) ELECTROLYSIS.

Owing to the destructive effects of the passage of the electric currents through the line of iron pipes, it was deemed unsafe to defer

longer the substitution of new pipes in that section of the 48-inch main line which runs through Boylston Street in Cambridge from the vicinity of the power station of the Boston Elevated Railway Company near the Charles River, to Eliot Street, not far from Harvard Square. The section replaced had a length of 827 feet and had been laid but a period of fourteen years. The new pipes have a thickness of 1.7 inches instead of the original thickness of 1.4 inches and, excepting at a curve, were laid with joints of wood instead of lead in order to secure insulation in the future. Pittings more or less deep and extended were found in all the discarded pipes, generally from $\frac{1}{2}$ inch to at least 1 inch in depth. In one of the lengths removed the pipe was so affected that four holes were made in cleaning out the pittings which had been caused by the action of the electric current.

The cost of relaying this section of the main was \$12,221.40, and is made a claim against the Railway Company.

The insertion of wooden instead of lead joints at intervals of about 500 feet has been adopted in all the lines of main pipe which have been recently laid, and it is believed that this is the most efficient means for the prevention or checking of electrolysis in the pipes which has yet been found.

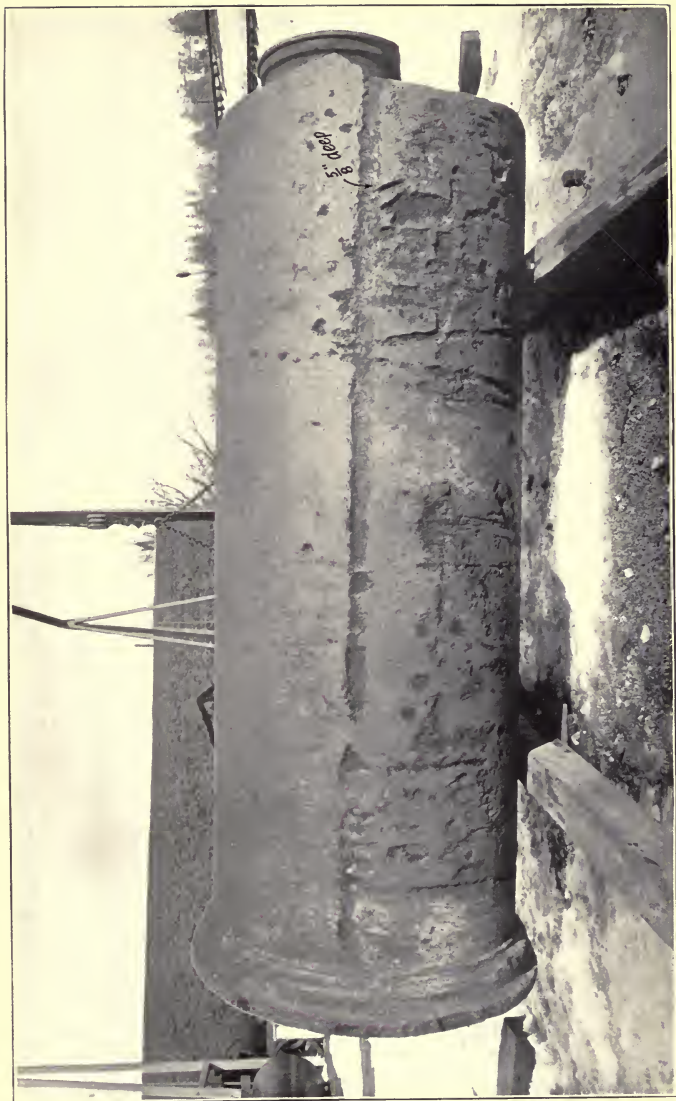
It is undoubtedly true, however, that great damage has been done in the past by the electrolytic action upon the pipes in various parts of the District, seriously weakening them in case of extraordinary pressure and decidedly shortening the period of their safe use.

V. WATER WORKS — FINANCIAL STATEMENT.

The financial abstract of the receipts, disbursements, assets and liabilities of the Board for the State fiscal year, beginning with December 1, 1909, and ending with November 30, 1910, was, in accordance with the requirements of chapter 235 of the Acts of the year 1906, presented to the General Court in January last, and a copy of this financial abstract is printed as Appendix No. 5.

The more detailed statement of its doings required by said chapter for the calendar year 1910, in relation to the Metropolitan Water Works, is herewith presented.

The Metropolitan Water Loans authorized for the construction and acquisition of works have amounted to \$41,878,000. To this



EFFECT OF ELECTROLYSIS UPON 48-INCH MAIN PIPE IN BOYLSTON STREET, CAMBRIDGE.

sum are added the proceeds from the sale of property by the Board, and these amounted on January 1, 1911, to \$288,574.04. The total amount, therefore, which the Board has been authorized to expend is \$42,166,574.04. The amount of expenditures approved by the Board for payment out of the Metropolitan Water Loan Fund was, for the year 1910, \$502,624.92, and the total amount so approved for payment since the beginning of the work up to January 1, 1911, has been \$41,546,929.56. There was accordingly a balance remaining at the beginning of the year 1911 amounting to \$619,-644.48.

The Treasurer of the Commonwealth has issued from time to time, on the request of the Board, bonds to the amount of \$41,398,000. These bonds were issued for terms of thirty-nine and one-half and forty years from the date of issue, and bear interest at the rate of 3 per cent. and $3\frac{1}{2}$ per cent. per annum. The sinking fund established for the payment of the bonds at maturity amounted on January 1, 1911, to \$8,089,902.91.

The increase in the debt, during the calendar year, as represented by the Metropolitan Water Loans outstanding, was \$500,000. The increase of the sinking fund for the payment of the debt at maturity was during the same period, \$863,640.60. There has been, therefore, a decrease of the net debt during the calendar year amounting to \$363,640.60.

The amount approved by the Board for the maintenance and operation of the Water Works for the year 1910, which was paid out of the annual assessments, was \$414,121.52.

The assessments for the year 1910 for the payment of interest on the bonds, for the sinking fund requirements and for the expenses of operation and maintenance of the Water Works, which were levied upon the various cities and towns in the Metropolitan District, amounted to \$2,297,787.77.

(1) METROPOLITAN WATER LOANS, RECEIPTS AND PAYMENTS.

The loans authorized for the construction and acquisition of the Metropolitan Water Works, the receipts which are added to the proceeds of these loans, the expenditures for the construction and acquisition of works, and the balance available on January 1, 1911, have been as follows:—

Loan under chapter 488 of the Acts of 1895, . . .	\$27,000,000 00
Loan under chapter 453 of the Acts of 1901, . . .	13,000,000 00
Loan under chapter 367 of the Acts of 1906, . . .	500,000 00
Loan under chapter 558 of the Acts of 1908, . . .	398,000 00
Loan under chapter 320 of the Acts of 1909, . . .	900,000 00
Loan under chapter 291 of the Acts of 1910, . . .	80,000 00
	<hr/>
	\$41,878,000 00

Receipts from the sales of property applicable to the construction and acquisition of works:—

For the year ending December 31, 1910, .	\$31,502 38	
For the period prior to January 1, 1910, .	167,071 66	
	<hr/>	198,574 04

Receipt from town of Swampscott for admission to the Metropolitan Water District paid into Loan Fund (St. 1909, c. 320),

90,000 00

\$42,166,574 04

Amount approved by the Metropolitan Water and Sewerage Board for payments out of the Water Loan Fund:—

For the year ending December 31, 1910, .	\$502,624 92	
For the period prior to January 1, 1910, .	41,044,304 64	
	<hr/>	41,546,929 56

Balance January 1, 1911, \$619,644 48

(2) ISSUES OF METROPOLITAN WATER LOAN BONDS.

The Treasurer of the Commonwealth, under the authority given him to issue from time to time, on the request of the Board, negotiable bonds to an amount not exceeding \$41,878,000, to be designated the "Metropolitan Water Loan," has sold bonds to the amount of \$41,398,000. The list of bonds sold prior to the year 1910 is given in the last (Ninth) Annual Report. The bonds sold in the year 1910 are as follows:—

DATE OF SALE.	Amount of Bonds sold.	Rate of Interest (Per Cent.).	Price received.	Date due.	Premium.
Feb. 10, 1910,	\$500,000	3½	100.39	Jan. 1, 1950	\$1,950 00

Prior to May 1, 1906, all premiums received from the sales of bonds were applied to the payment of the current charges in re-

duction of the annual assessments, but since that date, under the provisions of chapter 337, Acts of 1906, they have been paid into the sinking fund.

(3) METROPOLITAN WATER LOAN SINKING FUND.

The sinking fund established by the Treasurer of the Commonwealth has amounted at the end of each year to sums as follows:—

December 31, 1895, .	\$226,286 05	December 31, 1903, .	\$2,877,835 59
December 31, 1896, .	699,860 70	December 31, 1904, .	3,519,602 92
December 31, 1897, .	954,469 00	December 31, 1905, .	4,207,045 69
December 31, 1898, .	1,416,374 29	December 31, 1906, .	4,897,822 62
December 31, 1899, .	1,349,332 97	December 31, 1907, .	5,643,575 69
December 31, 1900, .	1,573,619 72	December 31, 1908, .	6,419,283 28
December 31, 1901, .	1,662,426 65	December 31, 1909, .	7,226,262 31
December 31, 1902, .	2,244,803 81	December 31, 1910, .	8,089,902 91

(4) ANNUAL ASSESSMENTS AND RECEIPTS.

Assessments for the year, amounting to \$2,297,787.77, were required for the payment of the interest on the bonds issued by the Commonwealth, the sinking fund requirements and the expenses of operation and maintenance of the Water Works. The requirements were: for interest, \$1,395,201.95; for the sinking fund, \$522,344.24; and for maintenance and operation, \$380,241.58. These assessments were made by the Treasurer of the Commonwealth upon the various municipalities as follows:—

Arlington, . . .	\$16,241 07	Nahant, . . .	\$4,357 11
Belmont, . . .	6,812 68	Newton, . . .	6,370 34
Boston, . . .	1,815,658 85	Quincy, . . .	50,950 31
Chelsea, . . .	47,716 42	Revere, . . .	23,139 93
Everett, . . .	45,937 13	Somerville, . . .	110,056 25
Hyde Park, . . .	1,316 24	Stoneham, . . .	9,670 13
Lexington, . . .	7,501 34	Swampscott, . . .	9,547 88
Malden, . . .	42,302 82	Watertown, . . .	16,082 35
Medford, . . .	32,690 39	Winthrop, . . .	16,681 77
Melrose, . . .	19,640 91		
Milton, . . .	15,113 85		
			<hr/>
			\$2,297,787 77

The comparatively smaller sums assessed upon the city of Newton and the town of Hyde Park were owing to the fact that neither of

these municipalities had reached the safe capacity of its own sources of water supply, and neither had been furnished with water.

The proceeds from the operations of the Board, exclusive of the proceeds from sales of property and of water, are required by statute to be applied to the payment of the interest, the sinking fund requirements and expenses of maintenance and operation of works. These for the year 1910 amounted to \$26,929.32.

The amount approved by the Board for the maintenance and operation of the Metropolitan Water Works was, for the year 1910, \$410,121.52.

(5) SUPPLYING WATER TO CITIES AND TOWNS OUTSIDE OF DISTRICT AND TO WATER COMPANIES.

Sums have been received during the year 1910, under the provisions of the Metropolitan Water Act, for water furnished, as follows:—

Town of Framingham,	\$559 20
United States Government,	1,954 46
Westborough State Hospital,	1,433 88
	<hr/>
	\$3,947 54

The sums so received prior to March 23, 1907, were annually distributed among the cities and towns of the District, but since that date, in accordance with the provisions of chapter 238 of the Acts of 1907, the sums so received have been paid into the sinking fund.

(6) EXPENDITURES FOR THE DIFFERENT WORKS.

The following is a summary of the expenditures made in the various operations for the different works:—

CONSTRUCTION AND ACQUISITION OF WORKS.	For the Year ending December 31, 1910.	From Beginning of Work to December 31, 1910.
Administration applicable to all parts of the construction and acquisition of the works, . . .	\$6,999 78	\$288,453 07
Wachusett Dam and Reservoir:—		
Wachusett Dam,	\$288 27	\$2,378,195 28
Power plant,	2,243 06	2,436 06
North Dike,	—	792,264 68
South Dike,	—	137,075 55
<i>Amounts carried forward,</i>	\$2,531 33 \$6,999 78	\$3,309,971 57 \$288,453 07

CONSTRUCTION AND ACQUISITION OF WORKS.	For the Year ending December 31, 1910.		From Beginning of Work to December 31, 1910.	
<i>Amounts brought forward,</i>	\$2,531 33	\$6,999 78	\$3,309,971 57	\$288,453 07
Wachusett Dam and Reservoir — Concluded.				
Removal of soil,	-		2,536,612 66	
Relocation of railroads,	-		881,872 45	
Roads and bridges,	-		547,867 76	
Real estate,	33,423 93		3,240,189 06	
Damages, real estate not taken, business and loss of wages,	-		532,247 07	
Other expenses,	-		8,547 92	
		35,955 26		11,057,308 49
Improving Wachusett watershed,	2,636 20			231,128 77
Wachusett Aqueduct,	-			1,797,948 85
Sudbury Reservoir,	13 25			2,923,146 96
Protection of Sudbury supply,	-			129,190 36
Improving Sudbury watershed,	-			95,711 84
Protection of Cochituate supply,	-			9,000 00
Improving Cochituate watershed,	-			8,860 68
Improving Lake Cochituate,	-			104,141 29
Pipe lines, Dam No. 3 to Dam No. 1,	-			48,471 48
Pipe line, Rosemary siphon,	-			23,142 98
Weston Aqueduct: —				
Aqueduct,	-		\$2,353,820 11	
Reservoir,	-		289,001 82	
Real estate, taxes and other expenses,	-		206,668 18	
		-		2,849,490 11
Distribution system: —				
Low service: —				
New 48-inch main, Section 31,	-		\$162,698 06	
Section 38, Tunnel (East Boston main),	\$32,322 27		32,322 27	
Pipe lines and connections,	38,957 77		1,791,985 02	
Pumping station, Chestnut Hill,	-		462,572 19	
Reservoir, Spot Pond,	-		582,188 73	
Gate-house and connections, Chestnut Hill Reservoir,	-		65,480 88	
Real estate and other expenses,	1,210 61		92,936 17	
Northern high service: —				
Pipe lines and connections,	22,577 50		527,485 76	
Spot Pond pumping station,	-		291,829 35	
Fells Reservoir, Stoneham,	-		141,392 94	
Bear Hill Reservoir, Stoneham,	-		38,267 70	
Real estate and other expenses,	-		14,838 05	
Southern high service: —				
Pipe lines and connections,	350 12		516,211 06	
Pumping station, Chestnut Hill,	60,542 32		307,694 70	
Forbes Hill Reservoir, Quincy,	-		90,003 49	
Waban Hill Reservoir, Newton,	-		61,592 11	
Real estate and other expenses,	-		10,226 36	
<i>Amounts carried forward,</i>	\$155,960 59	\$45,604 49	\$5,189,724 84	\$19,565,994 88

CONSTRUCTION AND ACQUISITION OF WORKS.	For the Year ending December 31, 1910.		From Beginning of Work to December 31, 1910.	
<i>Amounts brought forward,</i>	\$155,960 59	\$45,604 49	\$5,189,724 84	\$19,565,994 88
Distribution system — <i>Concluded.</i>				
Northern extra high service,	10,842 71		101,797 77	
Southern extra high service,	16 00		22,871 27	
Weston Aqueduct supply mains,	275,671 44		959,425 58	
Meters and connections,	2,170 11		84,615 69	
Improving Spot Pond Brook,	—		3,991 23	
Glenwood pipe yard,	—		33,100 59	
Chestnut Hill pipe yard,	—		11,311 26	
		444,660 85		6,406,838 23
Stock — pipes, valves, castings, etc., purchased and sent first to storage yards, and later transferred, as needed, to the various parts of the work: —				
Amount received,	\$199,162 23		\$2,471,141 97	
Transferred from storage yards to the various sections of the work and included in costs of special works,	186,802 65		2,320,946 81	
		12,359 58		150,195 16
Diversion of water, South Branch of Nashua River, ¹		—		1,363,935 31
Acquisition of existing water works: —				
Reimbursement city of Boston, partially con- structed Reservoir,	—		\$1,157,921 59	
Boston water works, taken January 1, 1898,	—		12,768,948 80	
Spot Pond taken from Malden, Medford and Melrose,	—		1,240,229 62	
Waban Hill Reservoir purchased from Newton, Expenses: —	—		60,000 00	
Engineering, \$22,617 52				
Conveyancing, 3,862 92				
Legal, expert and court, 46,648 03				
			73,128 47	
Deduct following, transferred and charged to special works: —				
Reimbursement city of Boston, transferred to Sudbury Reser- voir, \$1,157,921 59				
Waban Hill Reservoir transferred to Distribution Department, 60,000 00				
Stock — pipes, engines, etc., in- cluded with Boston Water Works and transferred to Dis- tribution Department, 22,340 91				
			1,240,262 50	
				14,059,965 98
Total for construction and acquisition of works,		\$502,624 92		\$41,546,929 56

¹ Of the total expenditures from the beginning of the work, the sum of \$150,939.89 is for Clinton sewerage system.

MAINTENANCE AND OPERATION.	For the Year ending December 31, 1910.	
Administration,		\$13,533 81
General supervision,		31,296 03
Taxes and other expenses,		36,030 04
Wachusett Reservoir Department: —		
Superintendence,	\$9,615 88	
Reservoir,	4,037 59	
Forestry,	6,718 58	
Protection of supply,	2,465 86	
Buildings and grounds,	2,863 21	
Wachusett Dam,	4,902 00	
Wachusett Aqueduct,	2,024 47	
Clinton sewerage system: —		
Pumping station,	3,576 88	
Sewers, screens and filter-beds,	11,174 31	
Sanitary inspection,	2,519 60	
Swamp drainage,	2,315 65	
		52,214 03
Sudbury Department: —		
Superintendence, Framingham office,	\$8,058 23	
Ashland Reservoir,	1,272 74	
Hopkinton Reservoir,	1,734 87	
Whitehall Reservoir,	466 60	
Framingham Reservoirs Nos. 1, 2 and 3,	6,261 02	
Sudbury Reservoir,	6,034 22	
Lake Cochituate,	7,160 87	
Marlborough Brook filters,	2,462 87	
Pegan filters,	2,913 20	
Sudbury and Cochituate watersheds,	858 48	
Sanitary inspection,	3,467 92	
Cochituate Aqueduct,	4,026 23	
Sudbury Aqueduct,	6,636 98	
Weston Aqueduct,	4,387 92	
Improving Lake Cochituate,	26,459 54	
		82,201 69
Distribution Department: —		
Superintendence,	\$4,256 54	
Arlington pumping station, pumping service,	7,350 04	
Chestnut Hill low-service pumping station, pumping service,	31,487 05	
Chestnut Hill high-service pumping station, pumping service,	42,136 74	
Spot Pond pumping station, pumping service,	13,834 71	
West Roxbury pumping station, pumping service,	6,382 79	
Arlington standpipe,	29 25	
Bear Hill Reservoir,	134 58	
Chestnut Hill Reservoir and grounds,	10,292 59	
Fells Reservoir,	597 40	
Forbes Hill Reservoir,	1,033 52	
Mystic Lake, conduit and pumping station,	1,260 82	
Mystic Reservoir,	944 43	
Waban Hill Reservoir,	340 25	
Amounts carried forward,	\$120,080 71	\$215,275 6

MAINTENANCE AND OPERATION.	For the Year ending December 31, 1910.	
<i>Amounts brought forward,</i>	\$120,080 71	\$215,275 60
<i>Distribution Department—Concluded.</i>		
Weston Reservoir,	2,347 19	
Spot Pond,	7,219 36	
Buildings at Spot Pond,	123 00	
Pipe lines:—		
Low service,	46,149 17	
Northern high service,	2,647 13	
Southern high service,	4,336 02	
Supply pipe lines,	559 37	
Buildings at Chestnut Hill Reservoir,	493 30	
Chestnut Hill pipe yard,	1,054 33	
Glenwood pipe yard and buildings,	4,033 83	
Stables,	6,361 54	
Venturi meters,	1,635 11	
Measurement of water,	1,448 93	
Arlington pumping station, buildings and grounds,	356 93	
		198,845 92
Total for maintaining and operating works,		\$414,121 52

(7) DETAILED FINANCIAL STATEMENT UNDER METROPOLITAN WATER ACT.

The Board herewith presents, in accordance with the requirements of the Metropolitan Water Act, a detailed statement of the expenditures and disbursements, receipts, assets and liabilities for the year 1910.

(a) *Expenditures and Disbursements.*

The total amount of the expenditures and disbursements on account of construction and acquisition of works for the year beginning January 1, 1910, and ending December 31, 1910, is \$502,624.92, and the total amount from the time of the organization of the Metropolitan Water Board, July 19, 1895, to December 31, 1910, is \$41,546,929.56.

For maintenance and operation the expenditures for the year have been \$414,121.52, and from the beginning of the work, \$4,225,168.78.

The salaries of the commissioners, and other expenses of administration, have been apportioned to the construction of the works and to the maintenance and operation of the same, and appear under each of those headings.

The following is a division of the expenditures according to their general character:—

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1910.	From Beginning of Work to December 31, 1910.
CONSTRUCTION OF WORKS AND ACQUISITION BY PURCHASE OR TAKING.		
<i>Administration.</i>		
Commissioners,	\$2,333 34	\$120,810 25
Secretary and auditor,	750 00	50,592 03
Clerks and stenographers,	1,658 68	62,632 84
Legal services,	—	2,359 00
Traveling,	13 68	3,674 57
Stationery and printing,	1,512 85	13,248 02
Postage, express and telegrams,	—	2,917 17
Furniture and fixtures,	5 50	4,288 64
Alterations and repairs of buildings,	80	5,790 97
Telephone, lighting, heating, water and care of building,	232 26	11,929 34
Rent and taxes, main office,	438 59	5,621 49
Miscellaneous expenses,	54 08	4,588 75
	\$6,999 78	\$288,453 07
<i>Engineering.</i>		
Chief engineer and department engineers,	—	\$207,471 36
Principal assistant engineers,	\$3,102 88	161,114 18
Engineering assistants,	7,978 67	1,045,992 89
Consulting engineers,	1,200 00	25,615 07
Inspectors,	7,710 54	303,471 05
Architects,	—	36,161 19
Railroad and street car travel,	694 51	27,579 13
Wagon hire,	—	45,337 53
Stationery and printing,	334 21	26,753 08
Postage, express and telegrams,	—	7,730 00
Engineering and drafting instruments and tools,	—	19,309 53
Engineering and drafting supplies,	29 23	25,019 51
Books, maps and photographic supplies,	60 71	7,049 93
Furniture and fixtures,	—	14,978 46
Alterations and repairs of buildings:—		
Main office,	34	14,109 30
Sub-offices,	—	2,939 36
Telephone, lighting, heating, water and care of buildings:—		
Main office,	696 81	26,454 47
Sub-offices,	—	19,667 82
Rent and taxes, main office,	1,315 80	16,632 95
Rent of sub-offices and other buildings,	—	4,526 74
Field offices and sheds,	—	1,274 49
Clinton office building,	—	9,866 87
Unclassified supplies,	13 65	8,264 87
Miscellaneous expenses,	47 76	8,992 75
	23,185 11	2,066,312 53
<i>Amounts carried forward,</i>	\$30,184 89	\$2,354,765 60

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1910.	From Beginning of Work to December 31, 1910.
<i>Amounts brought forward,</i>	\$30,184 89	\$2,354,765 60
<i>Construction.</i>		
Preliminary work (borings, test pits and other investigations):—		
Advertising,	\$202 98	\$6,661 89
Other preliminary work as given in detail in preceding annual report,	—	155,457 41
	202 98	162,119 30
Contracts, Wachusett Reservoir:—		
Contracts completed and final payments made prior to January 1, 1910,	—	\$5,406,738 30
McBride & Co., Stillwater improvement,	—	23,314 67
Sundry bills paid under this contract,	—	3,552 11
	—	5,433,605 08
Contracts completed, improving Wachusett Watershed,	—	11,893 75
Contracts completed, Wachusett Aqueduct,	—	1,447,208 55
Contracts completed, Sudbury Reservoir,	—	1,545,028 33
Contracts completed, protection Sudbury supply,	—	9,000 00
Contracts completed, improving Lake Cochituate,	—	60,657 45
Contracts completed, protection Cochituate supply,	—	9,000 00
Contracts completed, Rosemary siphon,	—	5,916 96
Contracts completed, pipe line, Dam No. 3 to Dam No. 1,	—	17,240 22
Contracts completed, Clinton sewerage system,	—	66,878 22
Contracts, Weston Aqueduct:—		
Contracts completed and final payments made prior to January 1, 1910,	—	2,376,004 54
Contracts, Distribution System:—		
Contracts completed and final payments made prior to January 1, 1910,	—	\$4,659,060 73
Coffin Valve Co., water valves,	\$8,607 00	8,607 00
Florence Iron Works, 60-inch cast-iron water pipes,	62,086 55	100,549 39
Standard Cast Iron Pipe and Foundry Co., special castings,	5,361 45	8,757 20
Standard Cast Iron Pipe and Foundry Co., special castings,	5,767 10	5,767 10
U. S. Cast Iron Pipe and Foundry Co., cast-iron pipes and special castings,	41,998 92	100,603 19
U. S. Cast Iron Pipe and Foundry Co., cast-iron pipes and special castings,	4,444 71	4,444 71
U. S. Cast Iron Pipe and Foundry Co., cast-iron water pipes,	5,249 07	5,249 07
<i>Amounts carried forward,</i>	\$133,514 80 \$30,387 87	\$4,893,038 39 \$13,499,318 00

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1910.		From Beginning of Work to December 31, 1910.	
<i>Amounts brought forward,</i>	\$133,514 80	\$30,387 87	\$4,893,038 39	\$13,499,318 00
<i>Construction — Con.</i>				
<i>Contracts, Distribution System — Concluded.</i>				
U. S. Cast Iron Pipe and Foundry Co., cast-iron water pipes,	36,831 30		36,831 30	
U. S. Cast Iron Pipe and Foundry Co., cast-iron pipes and special castings,	3,932 64		3,932 64	
Warren Foundry and Machine Co., cast-iron pipes and special castings,	4,769 04		4,769 04	
Warren Foundry and Machine Co., cast-iron pipes and special castings,	2,191 18		2,191 18	
Camoia & Williams, laying water pipes on Sect. 33, Chas. M. Callahan, laying water pipes on Sect. 35 of northern extra high-service pipe lines,	1,787 20		14,231 98	
Devincenzi & Baruffoldi, laying water pipes on Sect. 36 of northern extra high-service pipe lines,	4,292 38		4,292 38	
Chas. J. Jacobs Co., laying water pipes on Sect. 8 of Weston Aqueduct supply mains,	3,233 31		3,233 31	
Joseph Hanreddy, laying water pipes on Sect. 7 of Weston Aqueduct supply mains,	19,546 64		40,525 39	
Cavanagh Bros., laying water pipes on Sect. 6 of Weston Aqueduct supply mains,	52,300 19		52,300 19	
Michael Russo, laying water pipes on Sect. 37 of low-service pipe lines,	36,661 10		36,661 10	
Holly Manufacturing Co., furnishing and erect- ing pumping engine at the Chestnut Hill high-service pumping station,	11,823 18		11,823 18	
Standard Cast Iron Pipe and Foundry Co., cast- iron pipes and special castings,	50,000 00		50,000 00	
	3,609 61		3,609 61	
		364,492 57		
Deduct value of pipes, valves, etc., included in above list, transferred to maintenance account December 31, 1900,	-		\$5,157,439 69	
			3,139 77	
				5,154,299 92
<i>Additional work: —</i>				
Labor,	\$28,205 07		\$796,606 72	
Professional services, medical services, analyses, etc.,	1,698 00		3,680 99	
Traveling,	70		2,747 80	
Rent,	375 00		4,077 22	
Water rates,	-		1,454 77	
Freight and express,	393 25		13,862 57	
Jobbing and repairing,	247 90		9,946 08	
Tools, machinery, appliances and hardware supplies,	5,905 72		84,243 97	
Electrical supplies,	185 30		5,563 93	
<i>Amounts carried forward,</i>	\$37,010 94	\$394,880 44	\$922,184 05	\$18,653,617 92

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1910.	From Beginning of Work to December 31, 1910.
<i>Amounts brought forward,</i>	\$37,010 94 \$394,880 44	\$922,184 05 \$18,653,617 92
<i>Construction — Con.</i>		
Additional work — <i>Con.</i>		
Castings, ironwork and metals,	3,552 99	87,259 03
Iron pipe and valves,	13,709 23	75,762 40
Blasting supplies,	5 27	1,950 15
Paint and coating,	125 93	4,599 46
Fuel, oil and waste,	1,624 82	12,178 12
Lumber and field buildings,	2,817 10	90,011 88
Drain pipe,	72 00	9,235 80
Brick, cement and stone,	4,439 23	31,497 95
Sand, gravel and filling,	663 69	7,603 35
Municipal and corporation work,	5,592 68	220,664 67
Police service,	—	210,801 74
Sanitary inspection,	—	13,107 09
Judgments and settlements for damages,	—	53,124 26
Unclassified supplies,	266 78	17,978 30
Miscellaneous expenses,	85 78	6,154 25
	69,966 44	1,764,112 50
Legal and expert: —		
Legal services,	—	\$4,668 82
Expert services,	—	1,862 66
Court expenses,	—	1,317 20
Miscellaneous expenses,	—	185 80
	—	8,034 48
<i>Real Estate.</i>		
Legal and expert: —		
Legal services,	—	\$4,736 31
Conveyancer and assistants,	\$262 00	110,644 97
Experts,	137 35	18,008 93
Appraisers,	—	22,332 75
Court expenses,	—	11,139 43
Counsel expenses,	—	43 25
Conveyancing supplies,	6 00	3,190 53
Conveyancing expenses,	40 40	5,977 94
Miscellaneous expenses,	—	4,326 15
Settlements made by Board,	37,052 23	3,428,365 07
Judgments,	270 61	170,716 24
Taxes and tax equivalents,	—	68,182 41
Care and disposal,	9 45	86,901 14
	37,778 04	3,934,565 12
<i>Damages to Real Estate not taken, to Business and on Account of Loss of Wages.</i>		
Legal and expert: —		
Legal services,	—	\$1,130 67
Expert services,	—	2,857 62
Court expenses,	—	15,394 34
<i>Amounts carried forward,</i>	— \$502,624 92	\$19,382 63 \$24,360,330 02

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1910.	From Beginning of Work to December 31, 1910.
<i>Amounts brought forward,</i>	- \$502,624 92	\$19,382 63 \$24,360,330 02
<i>Damages to Real Estate not taken, to Business and on Account of Loss of Wages — Con.</i>		
Legal and expert — <i>Con.</i>		
Miscellaneous expenses,	-	125 00
Settlements,	-	415,513 65
Judgments,	-	116,733 42
	-	551,754 70
<i>Claims on Account of Diversion of Water.</i>		
Legal and expert: —		
Legal services,	-	\$3,774 98
Expert services,	-	19,339 69
Court expenses,	-	20,775 49
Miscellaneous expenses,	-	1,289 58
Settlements,	-	917,350 00
Judgments,	-	220,969 67
	-	1,183,499 41
<i>Purchase of Existing Water Works.</i>		
Legal and expert: —		
Legal services,	-	\$1,878 89
Expert services,	-	13,569 82
Court expenses,	-	29,728 38
Miscellaneous expenses,	-	1,470 94
Settlements and judgments,	-	15,227,100 01
	-	15,273,748 04
<i>Relocation Central Massachusetts Railroad.</i>		
Settlements,	-	177,597 39
Total amount of construction expenditures,	\$502,624 92	\$41,546,929 56

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1910.
MAINTENANCE AND OPERATION OF WORKS.	
Administration: —	
Commissioners,	\$5,833 33
Secretary and assistants,	6,173 66
Rent,	333 32
Repairs of building,	204 52
Fuel,	19 73
Lighting,	82 93
Care of building,	389 01
Postage,	36 00
<i>Amount carried forward,</i>	\$13,072 50

GENERAL CHARACTER OF EXPENDITURES.		For the Year ending December 31, 1910.	
Amount brought forward,		\$13,072 50	
MAINTENANCE AND OPERATION OF WORKS — <i>Con.</i>			
Administration — <i>Con.</i>			
Printing, stationery and office supplies,		409 12	
Telephones,		217 18	
Traveling expenses,		55 27	
Miscellaneous expenses,		37 74	
			\$13,791 81
General supervision: —			
Chief engineer and assistants,		\$24,975 63	
Rent,		1,000 00	
Repairs of building,		833 34	
Fuel,		59 18	
Lighting,		250 75	
Care of building,		1,167 20	
Postage,		119 00	
Printing, stationery and office supplies,		814 55	
Telephones,		740 09	
Traveling expenses,		409 55	
Miscellaneous expenses,		926 74	
			31,296 03
Pumping service: —			
Labor,		\$61,933 82	
Fuel,		34,332 78	
Oil, waste and packing,		1,398 44	
Repairs,		1,465 59	
Small supplies,		1,274 17	
Rent, West Roxbury pumping station,		786 53	
			101,191 33
Reservoirs, aqueducts, pipe lines, buildings and grounds: —			
Superintendents,		\$6,600 00	
Engineering assistants,		9,259 65	
Sanitary inspectors,		3,651 65	
Labor, pay roll,		125,580 59	
Labor, miscellaneous,		1,831 92	
Alterations and repairs of pumping stations,		79 91	
Alterations and repairs of other buildings and structures,		792 70	
Automobiles,		4,850 66	
Brick,		65 50	
Brooms, brushes and janitor's supplies,		144 79	
Castings, ironwork and metals,		955 65	
Cement and lime,		489 02	
Drafting and photo supplies,		100 12	
Fertilizer and planting material,		455 96	
Freight and express,		510 51	
Fuel,		3,257 89	
Amounts carried forward,		\$158,626 52	\$146,279 17

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1910.	
<i>Amounts brought forward,</i>	\$158,626 52	\$146,279 17
MAINTENANCE AND OPERATION OF WORKS — <i>Con.</i>		
Reservoirs, aqueducts, pipe lines, buildings and grounds — <i>Con.</i>		
Gypsy moth supplies,	684 46	
Hardware,	709 84	
Hay and grain,	2,113 86	
Horses,	543 50	
Lighting,	393 97	
Lumber,	1,738 73	
Machinery,	67 10	
Paints and oils,	1,077 63	
Pipe and fittings,	11,080 99	
Postage,	124 73	
Printing, stationery and office supplies,	647 98	
Rubber and oiled goods,	319 60	
Stable expenses,	844 90	
Sand, gravel and stone,	84 46	
Traveling expenses,	2,286 54	
Telephones,	930 41	
Teaming,	1,202 25	
Tools and appliances,	958 28	
Vehicles, harnesses and fittings,	409 09	
Municipal and corporation work,	135 83	
Miscellaneous expenses,	21,377 55	
Contracts: —		
Henry Spinach Contracting Co., contract 19-M, improvement of Lake Cochituate (surface-water drains in Framingham, Natick and Wayland),		25,712 09
		232,070 31
Payments in lieu of taxes,		35,772 04
Total expenditures for maintenance and operation,		\$414,121 52

(b) Receipts.

The total amount of receipts from the operations of the Board and from sales of property for the year beginning January 1, 1910, and ending December 31, 1910, is \$62,379.24, and the total amount from the time of the organization of the Metropolitan Water Board, July 19, 1895, to December 31, 1910, is \$714,973.06. The general character of these receipts is as follows:—

GENERAL CHARACTER OF RECEIPTS.	For the Year ending December 31, 1910.	From Beginning of Work to December 31, 1910.
For distribution back to District:—		
Fees for admission to District,	-	\$92,265 00
Water furnished to cities and towns outside of District,	-	90,454 77
Water furnished to water companies,	-	37,145 88
	-	\$219,865 65
To the credit of the loan fund:—		
Real estate and buildings,	\$5,991 32	\$44,039 34
Tools, supplies and reimbursements,	25,511 06	154,534 70
District entrance fees (Swampscott),	-	90,000 00
	\$31,502 38	288,574 04
To the credit of the maintenance fund:—		
Tools, supplies and reimbursements,	\$19,550 33	\$26,776 07
	19,550 33	26,776 07
To the credit of the sinking fund:—		
Water furnished to cities and towns outside of District and to water companies,	\$3,947 54	\$20,798 75
Forfeiture for contracts awarded but not exe- cuted,	-	500 00
Rents,	1,633 41	94,072 78
Land products,	5,544 58	60,926 86
Unclassified receipts and interest,	201 00	3,458 91
	11,326 53	179,757 30
Total receipts,	\$62,379 24	\$714,973 06

The foregoing receipts have been credited to the various objects or works, as follows:—

SOURCES OF RECEIPTS.	For the Year ending December 31, 1910.	From Beginning of Work to December 31, 1910.
Admission into Metropolitan Water District (Quincy, Nahant, Arlington, Stoneham, Milton, Lexington and Swampscott),	-	\$182,265 00
Supplying water to cities and towns outside of Water District (Swampscott, Revere, Lexing- ton, Wakefield, Cambridge, Framingham and U. S. Government), and to water companies (Framingham, Milton and Revere),	\$3,947 54	148,399 40
	\$3,947 54	\$330,664 40
Construction and acquisition of works:—		
Administration,	\$41 11	\$285 06
Wachusett Dam,	152 77	6,912 25
Amounts carried forward,	\$193 88 \$3,947 54	\$7,197 31 \$330,664 40

SOURCES OF RECEIPTS.	For the Year ending December 31, 1910.		From Beginning of Work to December 31, 1910.	
<i>Amounts brought forward,</i>	\$193 88	\$3,947 54	\$7,197 31	\$330,664 40
Construction and acquisition of works — <i>Con.</i>				
Wachusett Reservoir,	4,367 30		140,042 17	
Wachusett Aqueduct,	-		5,204 70	
Weston Aqueduct,	62 50		5,200 13	
Sudbury Reservoir,	25 00		10,640 42	
Distribution system,	26,982 31		101,340 59	
Diversion of water, Clinton sewerage system, .	-		1,367 94	
Purchase of existing water works,	-		18,119 08	
		31,630 99		289,112 34
Maintenance and operation of works: —				
Administration,	\$102 83		\$221 39	
General supervision,	450 00		1,252 76	
Wachusett Aqueduct,	293 71		4,973 78	
Wachusett Reservoir,	5,132 10		33,118 67	
Sudbury system,	2,221 09		17,684 47	
Distribution system,	18,136 93		32,602 46	
Clinton sewerage system,	464 05		5,342 79	
		26,800 71		95,196 32
Total receipts,		\$62,379 24		\$714,973 06

(c) *Assets.*

The following is an abstract of the assets of the Water Works, a complete schedule of which is kept on file in the office of the Board: —

Office furniture, fixtures and supplies; engineering and scientific instruments and supplies; police supplies; horses, vehicles, field machinery, etc.; machinery, tools and other appliances and supplies; real estate connected with works not completed; completed works, including real estate and buildings connected therewith.

(d) *Liabilities.*

The sums due on monthly pay rolls amount to \$1,594.72, and there are bills for current expenses which have not yet been received.

Amounts on Monthly Estimates, not due until Completion of Contracts or until Claims are settled.

NAME.	Work.	Amount.
McBride & Co.,	Contract 283, Stillwater improvement, Wachuset Reservoir.	\$778 09 ¹
Camoia & Williams,	Contract 308, Section 33 of northern high-service pipe lines, Distribution System.	689 29
Chas. M. Callahan,	Contract 316, Section 35 of northern high-service pipe lines, Distribution System.	225 92
Devincenzi & Baruffoldi,	Contract 322, Section 36 of northern extra high-service pipe lines, Distribution System.	100 00
Joseph Hanreddy,	Contract 314, Section 7 of the Weston Aqueduct supply mains.	9,052 97
Cavanagh Bros.,	Contract 323, Section 6 of the Weston Aqueduct supply mains.	4,116 67
Michael Russo,	Contract 326, Section 37 of low-service pipe lines, Distribution System.	1,262 92
Standard Cast Iron Pipe and Foundry Company.	Contract 325, cast-iron pipes and special castings.	636 99
The Henry Spinach Contracting Company,	Contract 19-M, improving Lake Cochituate, .	4,537 43
Holly Manufacturing Company,	Contract 312, pumping engine for Chestnut Hill low-service pumping station.	49,769 00

¹ Held pending settlement of claims on account of this contract.

It is impossible to state the amounts due on the claims of the following for land damages, for water rights taken and for damages to established business, as no sums have been agreed upon, and suits are now pending in court for the determination of most of them: —

Patrick Bradley, Henry F. Keyes, James E. Welch, Byron D. Allen, J. Frank Wood *et al.*, Asa Knight, Edward F. Merriam, Sanford C. Kendall, estate of William H. Vickery, James H. and Hannah S. Wood, Francis W. M. Goodale, heirs of Willard Morse, Caroline R. Braman, Charles G. Rice, Nehemiah W. Rice *et al.*, John Ward *et al.*, heirs of George K. Ward, heirs of Francis Pettee, William F. Harbach *et al.*, Fannie M. Flemming, Royal S. Wentworth *et al.*, trustees.

VI. METROPOLITAN SEWERAGE WORKS.

The North Metropolitan Sewerage District embraces the cities of Cambridge, Chelsea, Everett, Malden, Medford, Melrose, Somerville and Woburn, and the towns of Arlington, Belmont, Revere, Stoneham, Wakefield, Winchester and Winthrop, and parts of the city of Boston and the town of Lexington, — comprising in all 9 cities and 8 towns. The district has an area of 90.50 square miles, with an estimated population, based upon the United States Census of 1910, as of December 31, 1910, of 534,217. Of the total popu-

lation it is estimated that 87.1 per cent., or 465,302 people, contribute sewage to the North Metropolitan System. The sum of \$209,065.54 has been expended on account of construction during the past year. The total cost of the North Metropolitan Sewerage Works has been \$6,521,196.15.

The South Metropolitan Sewerage District includes the cities of Newton, Quincy and Waltham, and the towns of Brookline, Hyde Park, Milton and Watertown, and parts of the city of Boston and the town of Dedham, — a total of 4 cities and 5 towns. This district has an area of 100.87 square miles, with an estimated population as of December 31, 1910, of 359,670. According to the estimates made 64 per cent. of this population, or 230,365, contribute sewage to the South Metropolitan System. The sum of \$7,481.84 has been expended on account of construction during the past year. The total expenditures for construction of the South Metropolitan Sewerage Works have amounted to \$8,792,779.64.

Chapter 546 of the Acts of the Legislature of 1910 added the territory comprising the town of Braintree to the South Metropolitan District. This Act, however, was to take effect only when accepted by a majority of the legal voters of the town of Braintree present and voting thereon at a meeting legally called for the purpose. No action under the Act was taken by the town during the year.

(1) NORTH METROPOLITAN SEWERAGE SYSTEM — CONSTRUCTION.

(a) Deer Island Pumping Station Extension.

The work of extending the Deer Island pumping station and of installing a new pumping engine, with boilers and other apparatus, has been continued during the year and brought substantially to completion. The addition to the pumping station was 50 feet long and 45 feet, 8 inches wide, and there has been added a new coal house having a length of 103 feet and a width of 35 feet. These buildings have been erected so as to harmonize in general with the old station. There has been installed in the house a new pumping engine constructed by the Allis-Chalmers Company, having a capacity for pumping 100,000,000 gallons of sewage per day, with a lift of 19 feet. The engine was put into operation in the month of April. The operation of the engine and pumps in the ordinary working service of the station has been satisfactory, and the test which has been made has shown an efficiency and duty considerably in advance

of the stipulations made in the contract. The sum of \$177,707.76 has been expended, \$101,631.68 in connection with the building and \$76,076.08 for the pumping plant. The entire expense will come within the original appropriation of \$195,000.

(b) East Boston Pumping Station Extension.

Work has been continued during the year in completing the repairs to the East Boston pumping station, which was partially burned at the Chelsea fire, and in erecting the additions to the station and new coal house which had been contemplated. A pile wharf has been built in connection with the coal house, and this is to be made so far as possible fireproof. The parts of the new pumping engine to be furnished by the Allis-Chalmers Company have been delivered and are now in process of being set up. Boilers and other accessories have already been erected, and it is expected that the engine will be in condition to be put into operation in the first half of the coming year. The sum of \$160,175.85 has been expended on account of the extensions and pumping plant at this station. The cost of the repairs and renewals of the East Boston station, made necessary on account of the Chelsea fire, which will be chargeable to maintenance, has amounted to \$39,150.57, leaving a small balance from the total special appropriation of \$40,000.

(c) East Boston Stable and Locker Building.

A beginning has been made in the erection of a building for stable and locker purposes on the lot between Chelsea Street and the Grand Junction Railroad, near the East Boston pumping station, recently purchased in place of the old stable and locker lot, and the structure has been about half completed. The building and grounds will be made ready for occupancy during the coming season.

(2) SOUTH METROPOLITAN SEWERAGE SYSTEM — CONSTRUCTION.

Quincy Sewage Lift.

In accordance with the requirement of the original High-level Sewer Act, that the Metropolitan Sewerage Commission should build and operate such force mains and pumping stations as might be necessary to drain the sewerage system of the city of Quincy into the High-level Sewer, the Board was called upon by that city to provide

for the lifting of the sewage of the low district, comprising the easterly and southerly portions of Hough's Neck, into the main sewer.

The Board has, therefore, under the authority of chapter 292 of the Acts of 1910, proceeded to the erection of a small building on Island Avenue, about half a mile distant from the Nut Island screen-house, near which is built a storage well, and in which is also installed an automatic lift, to be operated by electricity generated at the Nut Island screen-house, from which the working of the lift is regulated. Two pumps, having each a daily capacity of 1,500,000 gallons, have been installed. The lift will be ready for operation early in the coming year.

(3) ACQUISITION OF LAND AND SETTLEMENTS.

The Board acquired during the year, by purchase, about 9,708 square feet of land on Chelsea Street and Chelsea Creek in East Boston, near the East Boston sewerage pumping station, for the purposes of a stable and locker building, for which the sum of \$4,463.40 was paid. A taking also of the parcel was afterwards made.

A settlement was also effected for an easement in 0.019 of an acre of land in Brookline, previously taken for the construction of the High-level Sewer, in which the sum of \$192.87 was paid.

Taking for Metropolitan Sewerage Works for the Year 1910.

No.	LOCATION AND DESCRIPTION.	Former Owner.	Re- corded.	Purpose of Taking.
24	East Boston, — on Addison Street and Boston & Albany Railroad. Area, fee in 9,708 square feet. Also rights of way in street and railroad location.	East Boston Company.	1910. Apr. 22.	For stable and locker building.

(4) NORTH METROPOLITAN SYSTEM — MAINTENANCE.

The cost of maintenance of the North Metropolitan System during the past year has been \$148,991. In addition to this, \$11,760 was expended in the repairs on the East Boston station from the special appropriation of \$40,000.

(a) Sewers and Pumping Stations.

The length of the sewers on the North Metropolitan System is 58.57 miles, and the Metropolitan sewers with connections with local

sewers have a combined length of 669.07 miles, involving 69,443 connections.

The sewage before it is finally disposed of in the harbor off Deer Island is lifted, the most of it at least twice and a portion three times, by pumping at the four stations, the Alewife Brook, Charlestown, East Boston and Deer Island pumping stations.

The daily average amount of sewage discharged into the harbor from the Deer Island outlet was 59,000,000 gallons, which was a daily average for each individual of the population contributing sewage of 126.8 gallons. This daily average is made larger from the fact that a considerable number of the local sewers permit the direct introduction of rain water. The total amount of the discharge is 1,600,000 gallons per day less than that of the preceding year, a decrease which is accounted for by the scarcity of the rainfall. The maximum amount of sewage discharged in any one day in the year was 135,100,000 gallons.

The pumping stations operated for the North Metropolitan Sewerage System are as follows:—

	No. of Engines.	Maximum Contract Capacity per Day (Gallons).	Lift (Feet).
Deer Island Station,	4	300,000,000	19
East Boston Station, ¹	3	165,000,000	19
Charlestown Station,	3	160,000,000	11
Alewife Brook Station,	3	23,000,000	8
			13

¹ The new pumping engine in process of erection for the East Boston pumping station will have a maximum contract capacity of 100,000,000 gallons, and a lift of 19 feet.

There were consumed for the operation of the pumping stations 7,329.21 tons of bituminous coal, which was purchased at average prices at the different stations varying from \$3.72 to \$4.38 per gross ton delivered in the bins.

The sums expended for the labor of engineers and their assistants in the various pumping stations of the district amounted to \$55,754.93.

The average cost per million gallons of sewage per foot lifted at the several stations was \$0.122.

(b) Siphons and Relocation of Sewers.

The siphons which were required to be introduced in the main sewer crossing the Alewife Brook in Arlington, in order to conform to the improvements made by the Metropolitan Park Commission, were substantially completed in the previous year, but were put into operation at the beginning of the past year. The cost of the changes made was \$2,634.27, and this sum was repaid by the Park Commission.

The siphon which was made necessary in the Metropolitan sewer in Cambridge, at Portland Street, by the building of the subway by the Boston Elevated Railway Company, was completed early in the year and put into operation. The introduction of this siphon requires the cleaning and flushing of the sewer as often as twice in each week by a gang of sewer men, causing a very considerable increase in the annual expenses of the District for maintenance. The construction of the subway also compelled a relocation of the Metropolitan sewer, originally built in Eliot Street and Eliot Square, by a detour into Murray Street. The old sewer was abandoned for a distance of 470 feet and its place was supplied by 660 feet of new sewer and iron pipes. By this relocation the introduction of another siphon was avoided. The necessary work involved was performed at both points by the Railway Company, at an approximate cost of \$29,000.

(c) Tanneries and Gelatine and Glue Works.

The quantity and character of the matter discharged into the Metropolitan sewers from the tanneries and the gelatine and glue works in the city of Woburn and the towns of Winchester and Stoneham have called for the serious attention of the Board.

Complaints have been made in the past of overflows from man-holes occurring in some instances during periods of heavy rain, from the Mystic Valley main sewer which receives the sewage of the city of Woburn and the town of Winchester. Careful investigations have been made with the view to ascertain whether this sewer had so nearly reached the proper limit of its capacity that the time had come to call for the construction of a supplementary main sewer for this district.

Upon the construction of the North Metropolitan Sewerage Sys-

tem the lower portion of the old Mystic Valley sewer, built by the city of Boston for the protection of the Mystic water supply, was taken to form a part of the Metropolitan System. The upper portion of the old sewer running through the town of Winchester and into the city of Woburn still remained the property of the city of Boston, and was subsequently taken over by the Board in connection with the city's water works. The manufacturing establishments were still permitted to use the upper part of the old sewer, under protective restrictions, for the discharge of their sewage and wastes into the Metropolitan System.

The investigations showed that these establishments had begun to neglect the restrictions which had been long before observed, and were emptying into this sewer great quantities of objectionable manufacturing wastes which were passing down and entering the Metropolitan sewer below. The wastes were of such a glutinous character as to clog the sewers, and, in fact, seriously to diminish their actual capacities for the carrying of sewage. The proprietors of the establishments were called upon to abide by the restrictions formerly made, and to provide settling tanks which should receive and collect the objectionable substances before any discharge from the works should enter the sewer. The municipal authorities were also notified that, unless the directions of the Board were observed, discharge into the Metropolitan sewers from the offending establishments would not be permitted.

After considerable delay on the part of some of the proprietors the Board's requirements have been complied with, and except in two cases settling tanks have been built and put in operation. In the two excepted cases the tanks are in process of construction.

It is still a question, independent of the admission of objectionable waste, whether the great quantities of liquids coming from these establishments should continue to be discharged into the Metropolitan System, which was intended for the disposal of sewage only.

The measures which have been taken will much improve the situation which has been complained of, and it is possible that by the observance of proper regulations the necessity for further and expensive sewer construction for the Mystic Valley will be deferred for a considerable period.

(5) SOUTH METROPOLITAN SEWERAGE SYSTEM — MAINTENANCE.

The entire cost of maintenance during the past year has been \$101,781.68.

Sewers and Pumping Stations.

The Metropolitan sewers in the South Metropolitan System have a length of 43.42 miles, and with these are connected local sewers having a length of 542.25 miles, requiring 148 connections.

The pumping stations operated for the South Metropolitan Sewerage System are as follows: —

	No. of Engines.	Maximum Contract Capacity per Day (Gallons).	Lift (Feet).
Ward Street Station,	2	100,000,000	45
Quincy Station,	3	18,000,000	28

The larger part of the sewage of the District is lifted into the High-level Sewer at the Ward Street pumping station in Roxbury, but the sewage of the city of Quincy is pumped into the sewer at Greenleaf Street near the Quincy pumping station. The entire sewage is screened at the Nut Island screen-house, and thence discharged at the bottom of the harbor about a mile off from the Island.

The average daily amount of the sewage thus discharged was 39,600,000 gallons, and the largest discharge in a single day was 141,000,000 gallons. The decrease in the daily average discharge from last year was 800,000 gallons.

The daily average discharge of sewage for each individual contributing sewage in the District was 171.9 gallons. The decrease from last year of 1.47 gallons was principally owing to the lack of heavy rains.

There were 2,810.81 gross tons of bituminous coal consumed at the two pumping stations and screen-house, which was purchased at average prices varying from \$3.98 to \$4.21 per gross ton delivered in the bins.

The expenditures for the labor of the engineers and their assistants at the three stations amounted to \$31,849.69.

VII. SEWERAGE WORKS—FINANCIAL STATEMENT.

The financial abstract of the receipts, expenditures, disbursements, assets and liabilities of the Metropolitan Water and Sewerage Board for the fiscal year of the Commonwealth ending with the thirtieth day of November, 1910, was, as stated in connection with the Water Works, presented to the General Court in January, in accordance with the requirements of chapter 235 of the Acts of the year 1906 and a copy of this financial abstract is in part printed as Appendix No. 5.

The following statement of its financial doings, in relation to the Metropolitan Sewerage Works, for the calendar year 1910, is herewith presented, in accordance with the provisions of the Act of 1906, as a part of the annual report of the Board.

The Metropolitan Sewerage Loans authorized for the construction of the Sewerage Works of the North Metropolitan System have amounted to \$6,573,865.73, to which are added receipts from various sources amounting to \$63,391.78. The amount of expenditures approved by the Board for payment for the year 1910 was \$209,065.54, and the total amount of expenditures approved to January 1, 1911, was \$6,521,196.15. The balance remaining on January 1, 1911, was \$116,061.36.

The loans authorized for the construction of the various parts of the South Metropolitan System have amounted to \$8,867,046.27. The receipts applicable to the loan fund have been \$13,401.13. The amount of expenditures approved for payment in the year 1910 was \$7,481.84. The total amount of expenditures approved for payment from the beginning of the works has been \$8,792,779.64. The balance remaining for the South Metropolitan System on January 1, 1911, was \$87,667.76.

The bonds issued on account of the loans have been for varying periods, not exceeding forty years, and bear interest at the rate of 3 per cent. and $3\frac{1}{2}$ per cent. The premiums received on account of the sale of bonds for the North Metropolitan System have amounted to \$179,547.35, and those received on account of the South Metropolitan System have amounted to \$410,132.03.

The increase in the debt during the calendar year, as represented by the Metropolitan Sewerage Loans, was \$113,000. The increase of the sinking fund for the payment of the debt at maturity was,

during the same period, \$257,957.49. There has consequently been a decrease in the net debt during the calendar year amounting to \$144,957.49.

The amount expended for maintenance of the North Metropolitan System in the year 1910 was \$160,751, and for the South Metropolitan System \$101,781.68, a total for both systems of \$262,532.68.

The assessments made to meet interest, sinking fund requirements and maintenance and operation of the North Metropolitan System amounted in the year 1910 to \$442,376.41, and the assessments for the South Metropolitan System amounted to \$457,071.75.

The following is a detailed financial statement regarding the Metropolitan Sewerage Works:—

(1) METROPOLITAN SEWERAGE LOANS, RECEIPTS AND PAYMENTS.

The loans authorized for the construction of the Metropolitan Sewerage Works, the receipts which are added to the proceeds of these loans, and the expenditures for construction, have been as follows:—

(a) *North Metropolitan System.*

Loans authorized under the various acts, including those for the Revere, Belmont and Malden extensions and North System enlargement and extension, \$6,573,865 73

Receipts from sales of real estate and from miscellaneous sources, which are placed to the credit of the North Metropolitan System:—

For the year ending December 31, 1910, . . . \$254 59¹

For the period prior to January 1, 1910, . . . 63,137 19¹

63,391 78

\$6,637,257 51

Amount approved for payment by the Board² out of the Metropolitan Sewerage Loan Fund, North System:—

For the year ending December 31, 1910, . . . \$209,065 54

For the period prior to January 1, 1910, . . . 6,312,130 61

6,521,196 15

Balance, North Metropolitan System, January 1, 1911, . . . \$116,061 36

¹ Of these amounts (\$130.60 for the year 1910), a total of \$16,960.61 was received directly by the State Treasurer and credited to this fund and not on our books until December, 1910.

² The word "Board" refers to the Metropolitan Sewerage Commission and the Metropolitan Water and Sewerage Board.

(b) South Metropolitan System.

Loans authorized under the various acts, applied to the construction of the Charles River valley sewer, Neponset valley sewer, High-level sewer and extension,

\$8,867,046 27

Receipts for pumping, sales of real estate and from miscellaneous sources, which are placed to the credit of the South Metropolitan System:—

For the year ending December 31, 1910, 1,994 31

For the period prior to January 1, 1910, 11,406 82

\$8,880,447 40

Amount approved by the Board¹ for payment out of the Metropolitan Sewerage Loan Fund, South System:—

On account of the Charles River valley

sewer, \$800,046 27

On account of the Neponset valley sewer, 911,531 46

On account of the High-level sewer and extension:—

For the year ending December 31, 1910, . \$7,481 84

For the period prior to January 1, 1910, . 7,073,720 07

7,081,201 91

8,792,779 64

Balance, South Metropolitan System, January 1, 1911, . \$87,667 76

(2) ISSUES OF METROPOLITAN SEWERAGE LOAN BONDS.

The Treasurer of the Commonwealth, under the authority of the successive statutes, has from time to time issued bonds designated "Metropolitan Sewerage Loan," amounting for the North System to \$6,563,000, and for the South System to \$8,877,912. The list of the bonds issued prior to the year 1910 is contained in the last (Ninth) Annual Report. The bonds issued in the year 1910 are as follows:—

¹ The word "Board" refers to the Metropolitan Sewerage Commission and the Metropolitan Water and Sewerage Board.

DATE OF SALE.	Amount of Bonds sold.	Rate of Interest (Per Cent.).	Price received.	Date due.	Premium.
Feb., 1910,	\$113,000	3½	100.39	Jan. 1, 1950	\$440 70

(3) METROPOLITAN SEWERAGE LOANS SINKING FUND.

Under the authority of chapter 122 of the Acts of the year 1899 the Treasurer and Receiver-General of the Commonwealth was required to consolidate the sinking funds of all the Metropolitan Sewerage Loans into one fund, to be known as the Metropolitan Sewerage Loans Sinking Fund.

The Board received during the year, from rentals and from other sources, to be applied to the sinking fund, \$182.19.

The sinking fund established has amounted at the end of each year to sums as follows:—

December 31, 1899, .	\$361,416 59	December 31, 1905, .	\$1,008,724 95
December 31, 1900, .	454,520 57	December 31, 1906, .	1,146,998 68
December 31, 1901, .	545,668 26	December 31, 1907, .	1,306,850 30
December 31, 1902, .	636,084 04	December 31, 1908, .	1,492,418 98
December 31, 1903, .	754,690 41	December 31, 1909, .	1,673,784 40
December 31, 1904, .	878,557 12	December 31, 1910, .	1,931,741 89

(4) ANNUAL APPROPRIATIONS, RECEIPTS AND EXPENDITURES.

The annual appropriations for the maintenance of the Metropolitan Sewerage Works, the receipts of the Board which are added to the appropriations for maintenance, and the expenditures for maintenance for the year ending December 31, 1910, have been as follows:—

North Metropolitan System.

Appropriation under chapter 388 of the Acts of 1910, . .	\$149,000 00
Balance of appropriation under chapter 582 of the Acts of 1908,	12,609 43
Receipts from pumping and from other sources, . . .	3,081 59
	<hr/>
	\$164,691 02
Amount approved by the Board for payment,	160,751 00
	<hr/>
Balance, January 1, 1911,	\$3,940 02 ¹

¹ Of this balance, \$849.43 is the remaining portion of the special appropriation of \$40,000 made by chapter 582 of the Acts of 1908, for the restoration and equipment of the East Boston pumping station, on account of the Chelsea fire of April 12, 1908.

South Metropolitan System.

Appropriation under chapter 340 of the Acts of 1910, . . .	\$103,200 00
Receipts from pumping and from other sources, . . .	253 50
	<hr/>
	\$103,453 50
Amount approved by the Board for payment, . . .	101,781 68
	<hr/>
Balance, January 1, 1911, . . .	\$1,671 82

(5) ANNUAL ASSESSMENTS.

Assessments for the year, amounting to \$442,376.41, for the North Metropolitan System and to \$457,071.75 for the South Metropolitan System, were required for the payment of interest and sinking fund requirements and the cost of maintenance and operation of works. The requirements for the North Metropolitan System were: for interest, \$192,230.07; for the sinking fund, \$108,827.97; and for maintenance, \$141,318.37. For the South Metropolitan System the requirements were: for interest, \$297,553.23; for the sinking fund, \$66,097.39; and for maintenance, \$93,421.13. The assessments for the North Metropolitan System were made upon the cities and towns in the District in accordance with chapter 369 of the Acts of the year 1906. Assessments for the South Metropolitan System were likewise made in accordance with said chapter, the period of five years for which apportionment was made under decree of the Supreme Judicial Court in the year 1905 having expired with the preceding year. The respective assessments were as follows:—

North Metropolitan Sewerage System.

Arlington, . . .	\$10,319 02	Revere, . . .	\$13,481 40
Belmont, . . .	5,545 04	Somerville, . . .	61,151 21
Boston, . . .	74,329 82	Stoneham, . . .	5,084 89
Cambridge, . . .	99,695 56	Wakefield, . . .	9,057 67
Chelsea, . . .	26,911 34	Winchester, . . .	11,008 98
Everett, . . .	25,610 54	Winthrop, . . .	9,662 19
Lexington, . . .	4,066 79	Woburn, . . .	11,505 50
Malden, . . .	39,209 87		<hr/>
Medford, . . .	20,901 64	Total, . . .	\$442,376 41
Melrose, . . .	14,834 95		

South Metropolitan Sewerage System.

Boston, . . .	\$195,328 79	Quincy, . . .	\$28,372 01
Brookline, . . .	83,289 83	Waltham, . . .	26,502 34
Dedham, . . .	11,219 96	Watertown, . . .	13,430 95
Hyde Park, . . .	14,148 98		
Milton, . . .	21,468 88	Total, . . .	\$457,071 75
Newton, . . .	63,310 01		

(6) EXPENDITURES FOR THE DIFFERENT WORKS.

The following is a summary of the expenditures made in the various operations for the different works:—

CONSTRUCTION AND ACQUISITION OF WORKS.	For the Year ending December 31, 1910.	From Beginning of Work to December 31, 1910.
<i>North Metropolitan System.</i>		
Original system, main line and branches, . . .	-	\$5,383,957 67
Lexington branch,	-	68,585 15
Everett branch,	-	54,877 12
Wakefield branch,	-	35,698 29
Stoneham branch,	-	11,574 10
Revere extension,	-	215,722 79
Chelsea and Everett outlets,	-	71,216 41
Wakefield branch extension,	-	190,081 97
Belmont extension,	-	57,363 06
Malden extension,	-	67,092 63
Bulkhead, Chelsea Creek,	-	3,231 00
North System, enlargement:—		
Administration,	\$3,119 25	\$8,917 77
Deer Island pumping station, extensions and additions,	57,308 03	177,707 76
East Boston pumping station, extensions and additions,	133,724 83	160,175 85
Malden-Everett extension, Section 66, . . .	632 20	632 20
Stable and locker, East Boston,	14,281 23	14,362 38
	\$209,065 54	361,795 96
Total for North Metropolitan System, . . .	\$209,065 54	\$6,521,196 15
<i>South Metropolitan System.</i>		
Charles River valley sewer, main line, . . .	-	\$800,046 27
Neponset River valley sewer:—		
Main line,	-	\$866,595 66
Brookline branch,	-	44,935 80
		911,531 46
High-level Sewer,	-	5,992,375 01
Amount carried forward,		\$7,703,952 74

CONSTRUCTION AND ACQUISITION OF WORKS.	For the Year ending December 31, 1910.	From Beginning of Work to December 31, 1910.
<i>Amount brought forward,</i>		\$7,703,952 74
<i>South Metropolitan System — Con.</i>		
High-level Sewer extension: —		
Completed sections,	—	\$831,627 43
Administration,	\$128 29	15,064 14
Section 85, Brighton,	519 80	227,375 50
Hough's Neck pumping station and connections,	6,640 88	6,640 88
Land takings, purchase and recording,	192 87	8,118 95
	\$7,481 84	1,088,826 90
Total for South Metropolitan System,	\$7,481 84	\$8,792,779 64
Total for construction for both systems,	\$216,547 38	\$15,313,975 79

MAINTENANCE.	For the Year ending December 31, 1910.	From Beginning of Work to December 31, 1910.
North Metropolitan System,	\$160,751 00	\$1,736,573 10
South Metropolitan System,	101,781 68	1,411,066 98
Total for maintenance, both systems,	\$262,532 68	\$3,147,640 08

(7) DETAILED FINANCIAL STATEMENT.

The Board herewith presents, in accordance with the Metropolitan Sewerage Acts, an abstract of the expenditures and disbursements, receipts, assets and liabilities for the year ending December 31, 1910:—

(a) Expenditures and Disbursements.

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1910.
CONSTRUCTION OF WORKS AND ACQUISITION BY PURCHASE OR TAKING.	
<i>North Metropolitan System.</i>	
Administration:—	
Commissioners,	\$1,166 67
Secretary,	375 00
Clerks and stenographers,	895 34
<i>Amount carried forward,</i>	\$2,437 01

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1910.
<i>Amount brought forward,</i>	\$2,437 01
<i>North Metropolitan System — Con.</i>	
<i>Administration — Con.</i>	
Traveling,	—
Stationery, printing and office supplies,	404 70
Telephone, lighting, heating, water and care of building,	133 39
Rent and taxes, main office,	113 51
Repairs of building,	7 62
Miscellaneous expenses,	23 02
	\$3,119 25
<i>Engineering: —</i>	
Chief engineer,	\$833 33
Engineering assistants,	4,784 52
Inspectors,	4,110 84
Traveling expenses,	320 71
Stationery, printing and office supplies,	155 69
Engineering and drafting instruments and tools,	1 60
Engineering and drafting supplies,	73 87
Telephone, lighting, heating, water and care of building,	404 77
Rent and taxes,	340 52
Repairs of building,	22 88
Miscellaneous expenses,	1,253 80
	12,302 53
Advertising,	\$36 73
Labor and teaming,	26,448 17
Tools, machinery and appliances,	12,727 03
Brick, cement, lumber and other field supplies and expenses,	12,017 06
	51,228 99
<i>Contracts: —</i>	
Woodbury & Leighton Co., contract 74, extension of engine, boiler, screen-house and coal-house at East Boston pumping station,	\$80,810 41
Allis-Chalmers Co., contract 68, addition to pumping plant at Deer Island pumping station,	17,307 50
Robb-Mumford Boiler Co. (Robb Engineering Co., Ltd., assignee), contract 78, furnishing and erecting six vertical fire-tube boilers with smoke flue and galleries, at the East Boston pumping station,	25,546 40
Hyde Windlass Co., contract 79, furnishing two sets of screens for the Deer Island pumping station,	5,600 00
John T. Scully Foundation and Transportation Co., contract 80, pile wharf, steel floor beams, braces and coal runs, for the East Boston pumping station,	8,618 91
	137,883 22
<i>Real estate: —</i>	
Settlements,	\$4,463 40
Legal, conveyancing and expert,	68 15
	4,531 55
Total for North Metropolitan System,	\$209,065 54

GENERAL CHARACTER OF EXPENDITURES.		For the Year ending December 31, 1910.
South Metropolitan System.		
High-level Sewer Extension.		
Administration:—		
Commissioners,		-
Secretary,		-
Clerks and stenographers,		-
Traveling,		-
Stationery, printing and office supplies,		\$90 71
Telephone, lighting, heating, water and care of building,		26 26
Rent and taxes, main office,		11 32
Miscellaneous expenses,		-
		\$128 29
Engineering:—		
Chief engineer,		-
Engineering assistants,		\$1,132 83
Inspectors,		402 78
Traveling expenses,		-
Stationery, printing and office supplies,		79 35
Engineering and drafting instruments and tools,		-
Engineering and drafting supplies,		8 18
Telephone, lighting, heating, water and care of building,		78 70
Rent and taxes,		33 95
Miscellaneous expenses,		-
		1,735 79
Advertising,		\$34 89
Labor and teaming,		31 00
Tools, machinery and appliances,		474 43
Brick, cement, lumber and other field supplies and expenses,		1,438 89
		1,979 21
Contracts:—		
Hugh Nawn Contracting Co., contract 65, Section 85, in part,		\$500 00
John Cashman & Sons Co., contract 87, Hough's Neck pumping station,		2,945 68
		3,445 68
Real estate:—		
Settlements,		\$192 87
Legal, conveyancing and expert,		-
		192 87
Total for South Metropolitan System,		\$7,481 84
MAINTENANCE AND OPERATION OF WORKS.		
North Metropolitan System.		
Administration:—		
Commissioners,		\$2,333 33
Secretary and assistants,		2,971 25
Rent,		325 43
Amount carried forward,		\$5,630 01

GENERAL CHARACTER OF EXPENDITURES.		For the Year ending December 31, 1910.	
Amount brought forward,		\$5,630 01	
North Metropolitan System — Con.			
Administration — Con.			
Heating, lighting and care of building,		216 62	
Repairs of building,		128 38	
Postage,		86 00	
Printing, stationery and office supplies,		692 89	
Telephones,		59 28	
Traveling expenses,		35 91	
Miscellaneous expenses,		41 63	
			\$6,890 72
General supervision: —			
Chief engineer and assistants,		\$6,387 59	
Rent,		976 32	
Heating, lighting and care of building,		614 15	
Repairs of building,		385 17	
Postage,		—	
Printing, stationery and office supplies,		249 07	
Telephones,		177 85	
Traveling expenses,		155 00	
Miscellaneous expenses,		76 83	
			9,021 98
Deer Island pumping station: —			
Labor,		\$15,669 91	
Fuel,		12,341 20	
Oil and waste,		439 66	
Water,		1,268 40	
Packing,		264 16	
Repairs and renewals,		1,244 57	
Telephones,		195 05	
General supplies,		1,561 00	
Miscellaneous supplies and expenses,		231 72	
			33,215 67
East Boston pumping station: —			
Labor,		\$18,317 42	
Fuel,		10,362 06	
Oil and waste,		424 80	
Water,		1,644 00	
Packing,		50 24	
Repairs and renewals,		623 08	
Telephones,		140 95	
General supplies,		636 68	
Miscellaneous supplies and expenses,		113 93	
			32,313 16
Charlestown pumping station: —			
Labor,		\$14,209 60	
Fuel,		3,838 56	
Oil and waste,		266 74	
Amounts carried forward,		\$18,314 90	\$81,441 53

GENERAL CHARACTER OF EXPENDITURES.		For the Year ending December 31, 1910.	
<i>Amounts brought forward,</i>		\$18,314 90	\$81,441 53
<i>North Metropolitan System — Con.</i>			
Charlestown pumping station — <i>Con.</i>			
Water,		453 60	
Packing,		33 27	
Repairs and renewals,		364 99	
Telephones,		67 85	
General supplies,		323 02	
Miscellaneous supplies and expenses,		97 56	
			19,655 19
Alewife Brook pumping station: —			
Labor,		\$7,558 00	
Fuel,		1,795 84	
Oil and waste,		231 20	
Water,		276 84	
Packing,		60 63	
Repairs and renewals,		461 03	
Telephones,		50 22	
General supplies,		85 15	
Miscellaneous supplies and expenses,		43 25	
			10,562 16
Sewer lines, buildings and grounds: —			
Engineering assistants,		\$2,575 00	
Labor,		24,996 32	
Automobiles,		88 82	
Brick, cement and lime,		628 14	
Castings, ironwork and metals,		273 25	
Freight, express and teaming,		10 66	
Fuel and lighting,		270 18	
Jobbing and repairing,		119 69	
Lumber,		592 82	
Machinery, tools and appliances,		545 13	
Paints and oils,		539 64	
Rubber and oiled goods,		685 82	
Sand, gravel and stone,		286 06	
Telephones,		10 10	
Traveling expenses,		504 19	
General supplies,		575 24	
Miscellaneous expenses,		274 73	
			32,975 79
Horses, vehicles and stable account,		\$4,356 33	
Renewal East Boston pumping station, account Chelsea fire, April 12, 1908: —			
Supplies and expenses,		11,760 00	
			16,116 33
Total for North Metropolitan System,			\$160,751 00
<i>South Metropolitan System.</i>			
Administration: —			
Commissioners,		\$2,333 33	
Secretary and assistants,		1,745 12	
<i>Amount carried forward,</i>		\$4,078 45	

GENERAL CHARACTER OF EXPENDITURES.		For the Year ending December 31, 1910.
<i>Amount brought forward,</i>		\$4,078 45
<i>South Metropolitan System — Con.</i>		
Administration — <i>Con.</i>		
Rent,	155 00	
Heating, lighting, and care of building,	201 85	
Repairs of building,	64 20	
Postage,	76 00	
Printing, stationery and office supplies,	623 56	
Telephones,	56 48	
Traveling expenses,	10 51	
Miscellaneous expenses,	27 78	
		\$5,293 83
General supervision: —		
Chief engineer and assistants,	\$7,561 59	
Rent,	465 00	
Heating, lighting and care of building,	605 57	
Repairs of building,	192 58	
Postage,	—	
Printing, stationery and office supplies,	180 09	
Telephones,	169 35	
Traveling expenses,	60 00	
Miscellaneous expenses,	102 28	
		9,336 46
Ward Street pumping station: —		
Labor,	\$18,446 92	
Fuel,	6,850 69	
Oil and waste,	329 24	
Water,	1,410 00	
Packing,	111 65	
Repairs and renewals,	336 82	
Telephones,	95 49	
General supplies,	971 88	
Miscellaneous supplies and expenses,	162 77	
		28,715 46
Quincy pumping station: —		
Labor,	\$6,273 60	
Fuel,	1,654 52	
Oil and waste,	44 01	
Water,	114 85	
Packing,	24 66	
Repairs and renewals,	273 25	
Telephones,	37 82	
General supplies,	82 79	
Miscellaneous supplies and expenses,	247 57	
		8,753 07
Nut Island screen-house: —		
Labor,	\$7,129 17	
Fuel,	1,568 45	
Oil and waste,	56 51	
<i>Amounts carried forward,</i>	\$8,754 13	\$52,098 82

GENERAL CHARACTER OF EXPENDITURES.		For the Year ending December 31, 1910.	
<i>Amounts brought forward,</i>		\$8,754 13	\$52,098 82
<i>South Metropolitan System — Con.</i>			
Nut Island screen-house — <i>Con.</i>			
Water,		179 28	
Packing,		28 69	
Repairs and renewals,		29 11	
Telephones,		60 80	
General supplies,		429 96	
Miscellaneous supplies and expenses,		40 29	
			9,522 26
Sewer lines, buildings and grounds: —			
Engineering assistants,		\$3,400 00	
Labor,		18,653 48	
Automobiles,		2,411 87	
Brick, cement and lime,		136 03	
Castings, ironwork and metals,		109 16	
Freight, express and teaming,		25	
Fuel and lighting,		71 72	
Jobbing and repairing,		19 64	
Lumber,		119 38	
Machinery, tools and appliances,		2,858 48	
Paints and oils,		427 52	
Rubber and oiled goods,		163 21	
Sand, gravel and stone,		18 75	
Telephones,		34 85	
Traveling expenses,		605 24	
General supplies,		149 83	
Miscellaneous expenses,		30 63	
			29,210 04
City of Boston, for pumping and interest,			7,700 00
Horses, vehicles and stable account,			3,250 56
Total for South Metropolitan System,			\$101,781 68

(b) Receipts.

The receipts from the sales of property, from rents and from other sources, have been credited as follows:—

ACCOUNT.	For the Year ending December 31, 1910.	From Beginning of Work to December 31, 1910.
North Metropolitan System — construction,	\$254 59	\$63,391 78
South Metropolitan System — construction,	1,994 31	13,401 13
North Metropolitan System — maintenance,	3,081 59	14,641 23
South Metropolitan System — maintenance,	253 50	1,730 20
Metropolitan Sewerage Loans Sinking Fund,	182 19	1,543 39
Totals,	\$5,766 18	\$94,707 73

(c) Assets.

The following is an abstract of the assets of the Sewerage Works, a complete schedule of which is kept on file in the office of the Board:—

Office furniture, fixtures and supplies; engineering and scientific instruments and supplies; horses, vehicles, field machinery, etc.; machinery, tools and other appliances and supplies; real estate connected with works not completed; completed works, including real estate connected therewith.

(d) Liabilities.

The sums due on monthly pay rolls amount to \$757.22, and there are other current bills unpaid which have not yet been received.

Amounts on Monthly Estimates, not due until Completion of Contracts or until Claims are settled.

NAME.	Work.	Amount.
High-level Sewer:—		
National Contracting Co., . . .	Sect. 73, contract abandoned,	\$5,516 17 ¹
E. W. Everson & Co., . . .	Sect. 75, contract 14,	1,000 00
High-level Sewer Extension:—		
Timothy J. O'Connell, . . .	Sect. 82, in part, contract 57,	60 00
Geo. M. Bryne Co., . . .	Sect. 85, in part, contract 63,	2,508 51
John Cashman & Sons Co., . . .	Hough's Neck pumping station and connections, contract 87,	519 82
North Metropolitan Construction:—		
Allis-Chalmers Co., . . .	Addition to pumping plant at Deer Island pumping station, contract 68,	17,307 50
Robb-Mumford Boiler Co. (Robb Engineering Co., Ltd., assignee), . . .	Furnishing and erecting six vertical fire-tube boilers with smoke flue and galleries, at the East Boston pumping station, contract 78,	6,386 60
Woodbury & Leighton Co., . . .	Extension of engine, boiler, screen-house and coal house at East Boston pumping station:— Contract 74A (maintenance), Contract 74B (construction),	865 00 8,681 73
		<u>\$42,845 33</u>

¹ Damages claimed by the Commonwealth on account of the abandonment of the contract exceed this amount.

Claims have been made by the following parties, but it is impossible to state the amounts due for land and other damages, as no sums have been agreed upon, and suits are now pending in the courts for the determination of most of them:—

Anna L. Dunican, Carrie S. Urquhart, N. Jefferson Urquhart, Edwin N. Urquhart, Richard Jones, James Doherty, Michael Niland, William H. Gibbons, Francis Normile, George A. Goddard.

VIII. RAINFALL AND WATER SUPPLY.

The amount of rain has been almost unprecedentedly small during the past year, and the scarcity has been more felt because for a period of years preceding there has been a rainfall less than the normal. The average rainfall for the past thirty-six years in which the records have been kept on the Sudbury watershed, is 45.31 inches, but during the past year the rainfall was but 35.64 inches. The rainfall on the Wachusett watershed was but 37.85 inches, against an average rainfall of 47.08 inches since the beginning of the records in the year 1897.

The amount of water collected and contributed to the water supply, which is affected by various circumstances, does not, however, exactly correspond to the rainfall. The yield or amount of water collected on the Sudbury watershed in the year 1910 was only 56 per cent. of the average amount of the years since the measurements have been made; and the amount so collected on the Wachusett watershed was but 73 per cent. of the average.

The accompanying diagram illustrates the remarkably small amount of water collected for the water supply during the past year in comparison with the previous years, and it also shows the comparatively smaller amounts collected during the past few years.

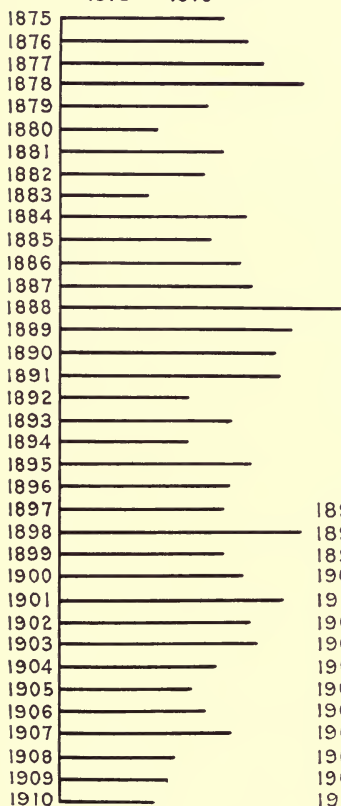
IX. CONSUMPTION OF WATER.

There has been for the second year a gratifying reduction in the total consumption of water in the Metropolitan District. The daily average consumption of water in the District in the year 1910 has been 112,092,100 gallons, which is a decrease of 7,027,000 gallons from the consumption of the year 1909, while that year showed a decrease in the daily average consumption of 6,305,100 gallons. The daily average consumption of each person in the District was 110 gallons, as against 119 gallons per person in the year 1909, and 129 gallons per person in the year 1908. These are the quantities determined by the Venturi meters as delivered to the various cities and towns. The quantity delivered to the District, according to the computation of water pumped at the several pumping stations and flowing in the Weston Aqueduct, including the small yield of the Spot Pond watershed, would, principally

COMPARATIVE AMOUNTS OF WATER COLLECTED IN THE
DIFFERENT YEARS ON THE SUDBURY AND WACHUSETT
WATERSHEDS PER SQUARE MILE OF WATERSHED.

SUDBURY WATERSHED.

1875 - 1910



WACHUSETT WATERSHED.

1897 - 1910



owing to leakage from distributing reservoirs and the Metropolitan pipes, and the small amounts supplied outside of the District, slightly exceed these figures.

There has been a decrease in daily consumption per capita in all the municipalities except Arlington, Belmont, Lexington, Malden, Melrose, Revere, Stoneham, Swampscott and Watertown. In the town of Winthrop there has been a decrease of 28 gallons daily per capita, and in the city of Medford a decrease of 16 gallons daily per capita, while in the city of Boston the daily per capita decrease has been 13 gallons. The total reduction of the consumption of the latter city for the year was 6,683,200 gallons, which makes up nearly the entire reduction in consumption of the District.

Of the municipalities named, in which there has been a per capita increase in the consumption, Stoneham shows a daily increase of 9 gallons and Watertown of 8 gallons. In the other municipalities the per capita increases have been small.

The notable reductions in the consumption in the cities of Boston and Medford and in the town of Winthrop have followed the larger installation of meters in those municipalities.

Although the reduction in consumption during the past year was assisted by the generally favorable character of the weather, and by the adoption on the part of the municipalities of more rigorous inspection and other preventive measures, it is undoubtedly principally due to the larger introduction of meters.

During the past year there has been a substantial compliance with the provisions of the Meter Act of 1907 by all the municipalities except the town of Revere and the city of Quincy. The city of Boston, on account of its almost total failure to observe the requirements of the law in the year 1908, is still behindhand in the total required to be installed on services in use on January 1, 1908 by about 2,200 meters, and its per cent., 19.96 per cent. of services metered, is the lowest of any municipality.

The town of Revere, although it introduced meters upon its new services, installed them upon less than 5 per cent. of old services as required by the Meter Act.

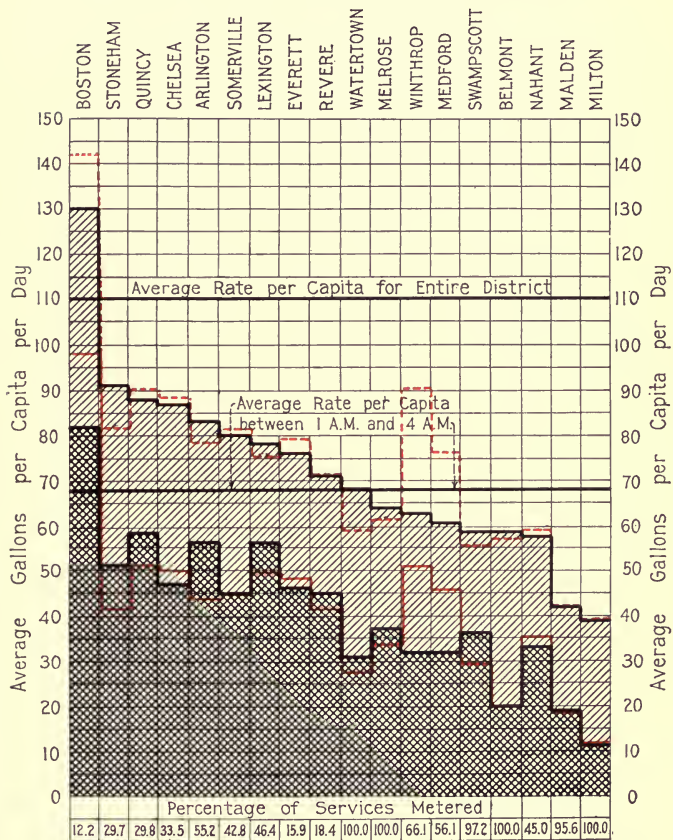
The city of Quincy failed in the year 1909 to comply with the provisions of the Meter Act, both as to the metering of the required percentage of old services and in the equipment of all new services.

The Board, in compliance with the provisions of chapter 177 of the Acts of 1909, gave notice of the neglect of the city to the Attorney-General, who brought action before the Supreme Judicial Court to enforce the requirements of the Act, and also for the forfeiture to the Commonwealth of the penalties prescribed. By reason, however, of the representations made by the officials of the city as to the measures which they were taking in order to install the necessary number of meters, further proceedings in the suit were suspended. A large number of meters were installed during the latter portion of the year, and it is understood that during the coming year the city will have fully complied with the terms of the Act, and will not compel the further prosecution of the action which is pending.

The city of Melrose and the towns of Belmont, Milton and Watertown have metered all their services. The town of Swampscott, the city of Malden, the town of Winthrop and the city of Medford have installed meters to the extent respectively of 99, 96, 96 and 94 per cent. of the services. At the end of the year, 37.56 per cent. of all the services in the Metropolitan District were metered, a gain during the year of 9.21 in the percentage.

The fact still remains, notwithstanding the reductions which have been made, that there is an excessive use and great waste of water in the Metropolitan District. The diagram which is again reproduced, showing the average rate of consumption in the year 1910 during the entire day and between the hours of 1 and 4 in the night, significantly demonstrates this fact. The daily average rate of consumption per capita in the night, when necessary use is comparatively very small, is 68 gallons. This night rate in the city of Boston is 60 per cent. of the rate for the entire day, and exceeds the rate for the entire day of 13 municipalities. The result which has been brought about by the metering of even 19.96 per cent. of the services in the city of Boston, and the somewhat greater efforts which have been made by the authorities to restrict unnecessary use, conclusively indicate the importance of universal metering and more vigorous measures for the prevention of excessive use and waste, especially in that city which consumes 78 per cent. of all the water supplied. The city of Boston alone can put off for a long period in the future the necessity of a great expenditure for the acquisition of additional sources of supply and of new and expensive works.

DIAGRAM SHOWING
 AVERAGE RATE OF CONSUMPTION OF WATER
 IN THE METROPOLITAN DISTRICT IN 1910
 DURING THE ENTIRE DAY
 AND
 BETWEEN THE HOURS OF 1 AND 4 AT NIGHT



Daily Average Rate of Consumption 1910.....
 " " " Night " between 1 A.M. and 4 A.M. 1910.....
 Daily Average Rate of Consumption in 1909 shown in Red-----

X. RECOMMENDATIONS FOR LEGISLATION.

The Board in its preliminary report to the Legislature has made no requests for the authorization of additional expenditures for the construction of new works, either for the Water or Sewerage systems, and the loans already authorized are deemed sufficient for the completion of the works in progress.

The Board has requested the passage of an act providing that in case the town of Braintree should apply for admission into the South Metropolitan Sewerage District, and an extension of the sewer into that town should thus become necessary, balances in the treasury not needed for the purposes for which the appropriations were made may be used for the Braintree extension, and thus avoid the necessity of the immediate issue of further bonds.

XI. FUTURE WORK.

The maintenance and operation of the various works for the supply and distribution of water in the cities and towns of the Metropolitan Water District, and of the works constructed for the collection and disposal of the sewage in the cities and towns of the North and South Metropolitan Sewerage districts, will require, according to the estimates for the current year which have been made and submitted to the Legislature, appropriations amounting to \$674,400. In these estimates, in addition to the ordinary current expenditures, the Board has included the sum of \$15,000, which it deems necessary to expend for the protection of the water supply in aqueducts. The growth of the population having caused the construction of new houses in districts adjacent to the aqueducts before local sewers have been provided, it has become necessary to provide, temporarily at least, for the house drainage in such adjacent districts so as to prevent the pollution of the water carried through the aqueducts.

The carrying out of projects already begun will require a considerable amount of construction during the coming year. The installation of a power plant at the Wachusett Dam, by which electricity will be generated and for which contracts have already been made, will be carried on to completion. The tunnel and pipe line for the improvement of the East Boston water supply will be finished and put into operation, a further section of the 60-inch

supply pipe line, which is to extend from the Weston Aqueduct to the Chestnut Hill Reservoir, will be made ready and put into service, and the new engine, which is in process of erection at the Chestnut Hill pumping station, will be completed and put into operation.

In the North Sewerage System the final work in the extensions of the Deer Island and East Boston pumping stations and installation of new pumping machinery will be accomplished, and the new stable and locker building will be constructed; and in the South Sewerage System the small station in process of construction for lifting the sewage of a portion of the city of Quincy into the High-level Sewer will be completed and put into operation. If the town of Braintree applies for admission into the South Metropolitan Sewerage District it will be necessary to proceed at once to the construction of a sewer from a point in Quincy to connect with the sewerage system in the town of Braintree, for which the expenditure of \$100,000 has been authorized.

Requests for information have been made by various municipalities relative to their admission into the Metropolitan Water District. Some of these municipalities are situated within the ten-mile limit, and it is made by the Metropolitan Water Act obligatory upon the Board to grant their applications for admission on their payment of such sums as the Board shall determine. Municipalities outside of the limit can only be admitted by act of the Legislature. In case other cities or towns are admitted new work of greater or less magnitude will be called for.

The town of Hyde Park, which belongs to the Metropolitan Water District, but has not yet asked to be furnished with water, has been considering for some time the question of resorting to the Metropolitan Works for its supply. In case the town shall so vote it will become at once the duty of the Board to proceed to make connection with the local water system of the town, and construct such new works as may be required in order to furnish a proper water supply.

The large amount of sewage which is now carried into the harbor through the Deer Island outlet has caused the Board to consider the desirability of making some improvement in the future in the method of its discharge. Various inquiries have been instituted in

the matter, but further investigations will be required as to the effect of the disposal of the sewage in the harbor and to determine what measures may be adopted in order to secure the best and most effective method by which the sewage can be discharged into the sea from the North Metropolitan System.

The detailed reports of the Chief Engineer of the Water Works and of the Chief Engineer of the Sewerage Works, with various tables and statistics are herewith presented.

Respectfully submitted,

HENRY H. SPRAGUE,
HENRY P. WALCOTT,
JAMES A. BAILEY, JR.,
Metropolitan Water and Sewerage Board.

BOSTON, February 27, 1911.

REPORT OF CHIEF ENGINEER OF WATER WORKS.

To the Metropolitan Water and Sewerage Board.

GENTLEMEN:—The following is a report of the work under the charge of the Chief Engineer of the Metropolitan Water Works for the year ending December 31, 1910.

GENERAL STATEMENT.

The Chief Engineer has charge of the design and construction of all new works, and of the maintenance and operation of all the works controlled by the Metropolitan Water and Sewerage Board for supplying water to the eighteen municipalities which have received their supply from the Metropolitan Works.

ORGANIZATION.

The Chief Engineer has had the following assistants:—

William E. Foss, .	. Assistant to Chief Engineer.
Elliot R. B. Allardice, .	. Superintendent, Wachusett Department.
Charles E. Haberstroh, .	. Superintendent, Sudbury Department.
Samuel E. Killam, .	. Superintendent, Pipe Lines and Reservoirs, Distribution Department.
Arthur E. O'Neil, .	. Superintendent, Pumping Stations, Distribution Department.
Alfred O. Doane, .	. Division Engineer, specially in charge of engineering work at pumping stations.
George E. Howe, .	. Assistant Engineer, resigned April 30, 1910.
Barzillai A. Rich, .	. Assistant Engineer, employed since June 8, 1910.
Clifford Foss, .	. Assistant Engineer.
Benjamin F. Hancox, .	. Assistant, in charge of Drafting Department.
James W. Killam, .	. Assistant Engineer, in charge of tests of coal and oil.
William E. Whittaker, .	. Office Assistant.
Arthur W. Walker, .	. Biologist.
William W. Locke, .	. Sanitary Inspector.

At the beginning of the year the engineering force, including those engaged upon both the construction and maintenance of the works, numbered 48, and at the end of the year 51.

There has also been a maintenance force, exclusive of the engineers above mentioned, averaging 249, employed in the operation of the several pumping stations and in connection with the maintenance of the reservoirs, aqueducts and pipe lines, and in doing minor construction work.

The number of men employed in the maintenance force of the several departments has been as follows:—

	Beginning of Year.	End of Year.	Average.
Wachusett Department,	37	39	49
Sudbury Department.	43	56	53
Distribution Department, pipe lines and reservoirs, . .	76	91	88
Distribution Department, pumping service,	60	58	59
	216	244	249

In addition to the men employed directly by the Board a force averaging 167 men, reaching a maximum of slightly over 300 in September, was employed from April 1 to December 31 by the contractors engaged in constructing new works.

CONSTRUCTION.

NEW 60-INCH SUPPLY MAIN FROM WESTON AQUEDUCT.

An expenditure of \$750,000 was authorized by the Legislature of 1909 for the construction of a second Weston Aqueduct supply main, for the purpose of increasing the amount of water that can be supplied from the Weston Aqueduct into the Metropolitan District.

The new main will extend from the Charles River at Commonwealth Avenue in Newton to Beacon Street at Chestnut Hill Avenue in Boston, a distance of about 34,650 feet, and will be located for a large portion of the distance in Commonwealth Avenue. On account of the large reduction now being made in the amount of water used in the District it has not been deemed necessary to construct the entire line at present, and the work of construction

is therefore being confined to the portion of the line extending 20,255 feet westerly from the lower end, at Beacon Street in Boston. This section of the pipe line has been connected at the lower end with the low-service mains in Beacon Street, and at the upper end it will be connected with the existing 48-inch Weston Aqueduct supply main, near Valentine Street, in Newton, and when put into service it will materially increase the amount of water that can be drawn from the Weston Aqueduct.

Cast-iron pipes 60 inches in diameter have been used in constructing the line, except for a distance of 2,395 feet, where the water will be carried through a concrete-lined rock tunnel 76 inches in diameter, connected with the 60-inch pipes by steel pipes 80 inches in diameter. The steel pipes will be protected from corrosion on the inside by a Portland cement mortar lining 2 inches thick, and on the outside by a backing of Portland cement concrete, which will also serve as a support for the pipe.

The tunnel and steel pipe line are being constructed of larger capacity than the remainder of the line in order to provide carrying capacity for an additional pipe line in the future.

Contracts for furnishing the cast-iron pipe and most of the special castings for the portion of the line now under construction were made in 1909. Contracts for the special castings required to complete the work have been made during the past year. A contract for furnishing the steel pipe was made with the Hodge Boiler Works on December 6, but the delivery of the pipe will not be made until 1911. The portion of the pipe line under construction has been subdivided into three sections, known as sections 6, 7 and 8.

Section 6 is located in Commonwealth Avenue in Newton, and extends from a point midway between Prince and Valentine streets to Grant Avenue, at *Section 7*, a distance of 8,825 feet. The contract for doing this work was made with Cavanagh Brothers of Boston, on June 2. On the following day a special steam shovel excavator, designed by the contractor, was set up near Grant Avenue, where trench excavation was started on June 8. Pipe laying was begun at this point on June 15 and on July 16 about 650 feet of pipe had been laid. The force employed at this time was about 35 men.

On account of difficulties arising in connection with the use of the steam shovel and dump cars, and from obstacles encountered in the trench, slow progress was made in pipe laying. The contractor therefore increased his force to about 75 men, abandoned the use of the cars, and employed teams for transporting the excavated material. This change in method of carrying on the work resulted in the making of better progress and this organization was continued until the completion of the work.

Trench excavation was started at the large culvert near Walnut Street on July 18, and 700 feet of trench at this place was excavated by manual labor. Pipe laying was completed and the line capped at the westerly end, between Prince and Valentine streets, on November 26.

A 36-inch branch was set in the line near Valentine Street for a connection with the 48-inch Weston Aqueduct supply main. A 36-inch valve with 6-inch by-pass was set in the line just west of this branch. A blow-off branch into the Cochituate Aqueduct was placed at Irving Street.

The surplus material from the easterly 6,000 feet of the line was sand and gravel, and was teamed to Section 7, where a portion of it was used in building the embankment over the 60-inch pipe line, and the remainder placed in a storage pile to be used for filling the steel pipe trench on that section. The entire work was completed on December 3. The value of the work done under this contract was \$40,777.77.

Section 7 of the new pipe line is located in Newton, and extends from Commonwealth Avenue at Grant Avenue through and under private land to the westerly end of Section 8. It includes 2,042 feet of concrete-lined rock tunnel, 353 feet of cement-lined steel pipe and 940 feet of 60-inch cast-iron pipe.

A contract for this work was made with Joseph Hanreddy of Chicago on April 28. The work of excavating the trench at the west end of the section was begun on May 24, with a force of about 20 men and 9 horses, preparatory to laying the pipe at this place. This force was later increased to about 55 men.

Steam plants, with air compressors for operating the drills, dynamos for lighting the tunnel and engines for operating the stone crushers have been installed at both ends of the tunnel.

The laying of 60-inch pipe was begun at Commonwealth Avenue on June 7, and continued in an easterly direction until June 14, when 334 feet of pipe had been laid. This section of the line was laid near the surface of the ground, and covered with an embankment built of surplus material from the 60-inch pipe trench on Section 6.

On June 17 the laying of pipe was begun at the easterly end of the section, and continued westerly until July 1, when 185 feet of pipe had been laid. A 36-inch valve with 6-inch by-pass was set in the line at this point, and a 16-inch blow-off pipe was laid into the culvert under the Cochituate Aqueduct near the ventilator chamber. Pipe laying was resumed at this place on September 15 and continued to October 1. The total length of 60-inch pipe laid to date on this section is 664 feet.

On July 7 the steam plant at the west end of the tunnel was put into operation, and on July 13 the crushing of rock from the open trench was commenced. Rock excavation in the open trench was completed July 23, and tunnel excavation was begun on July 26 at the west portal. Night work was begun at the west heading on August 1, and tunnel excavation was then continued with two shifts at this heading.

The tunnel is excavated 9 feet in diameter, and is located about 9 feet north of and 20 feet above the old Cochituate Aqueduct tunnel, which was constructed through the hill at this place by the city of Boston in 1848.

Tunnel excavation was begun at the east portal on September 9, and night work was commenced on September 19. The excavation of the tunnel was then continued, with night and day forces, from the east portal until December 24, and from the west portal until December 29. The force employed at each heading consisted of about 12 men on each shift. From 15 to 21 holes, from 5 to 6 feet in depth, were drilled per shift in each heading, and then blasted, and the progress made when working two shifts at both headings was about 20 linear feet per working day.

The material excavated at the west heading was soft conglomerate rock, with a few hard spots in places, and comprised about three-fourths of the tunnel excavation. This rock was free from seams

and broke close to the established line for tunnel excavation. At the east end of the tunnel the rock was hard and brittle, with numerous fissures and cracks, which caused the excavation to break out unnecessarily large at some places, and timbering was required for about 30 feet. Timbering was also required to support the rock at six old shafts on the Cochituate Aqueduct tunnel, and at an earth seam near the westerly end of the tunnel.

On December 28 a hole was broken through from the west heading into the east heading of the tunnel. After the muck was removed the entire force was discharged, and the work suspended for the winter on December 31. With the exception of a little trimming the tunnel excavation is now completed.

The value of the work done to date under this contract is \$65,385.41, equivalent to about 60 per cent. of the total value of the work to be done.

At the west end the length of tunnel excavation was 1,210 feet, and at the east end 832 feet, making a total length of 2,042 feet. The average length of tunnel excavated per working day was 15.1 feet. At the west end of the tunnel 5,553 cubic yards of stone have been crushed, of which 1,924 cubic yards have been used for resurfacing the 60-inch pipe trench in Commonwealth Avenue. At the east end of the tunnel 4,226 cubic yards of stone have been crushed.

About 2.30 A.M. on December 6, powderman Constanzo Trambuzzi was killed by the explosion of the dynamite which was to be used for loading the holes in the east heading of the tunnel. The cause of the explosion is not known.

Section 8 includes the easterly 8,095 feet of the proposed line, 3,100 feet of which is located in private land in Newton and 4,995 feet in Commonwealth and Chestnut Hill avenues in Boston.

Work on this section, which was begun last year by the Charles J. Jacobs Company, was suspended for the winter on December 24, 1909, after 5,349 feet of pipe had been laid. The work was resumed on March 30, 1910, and was continued with a force of from 40 to 80 men. The work progressed slowly, on account of the large amount of rock which had to be excavated in the trenches on Commonwealth Avenue, and was not completed until August 10.

A 60-inch Venturi meter, with 27-inch throat, was set in the pipe line on Chestnut Hill Avenue near Beacon Street, where the main connects with the existing 48-inch main.

The value of the work done by the C. J. Jacobs Company during the year was \$14,622.86, making the total cost of the work done by this contractor \$40,525.39.

The length of 60-inch pipe laid during the year was 2,746 feet, making a total length laid of 8,095 feet, and the amount of rock excavated during the year was 1,092 cubic yards, making a total of 3,610 cubic yards.

The value of all work done on the construction of the new supply main to date is as follows:—

Pipes, special castings and valves,	\$209,710 61
Venturi meter,	2,350 00
Laying pipes, including pipe-laying materials and earth excavation,	61,061 58
Rock excavation in trenches,	15,735 50
Tunnel excavation, Section 7,	50,245 50
Earth excavation for trenches, Section 7,	3,712 20
Crushing stone, Section 7,	7,334 25
Valve chambers and concrete backing for curves,	2,407 00
Work in connection with changes in underground structures,	6,765 56
Resurfacing trench in Commonwealth Avenue, Section 6, labor by city of Newton,	4,357 16
Additional expenses,	9,854 64
Engineering,	15,173 08
Total,	<hr/> \$388,707 08

16-INCH FORCE MAIN IN ARLINGTON.

The 16-inch main leading from the Arlington pumping station has been extended from Massachusetts Avenue through Robbins Road, Hawthorne and Park avenues to the standpipe on Arlington Heights, a distance of 3,750 feet. The work of laying the main was done by Devincenzi & Baruffoldi under a contract dated May 5, 1910. The contractor began work on May 11, employed an average force of 22 men and completed the pipe laying on July 28. The value of the work done under this contract, which included the laying of 3,742 feet of 16-inch pipe and excavation of 408 cubic yards of rock, was \$3,333.31. Connections between this main and existing pipes

were made by the maintenance force, which also made 8 wooden insulating joints on the pipe line. The total cost of the work, exclusive of engineering, was \$10,094.02.

The laying of this main reduced by about 5 feet the head or pressure on the pumps at the Arlington station, and at the same time relieved the pressure on the Arlington pipe system.

NEW 16-INCH MAIN FOR SUPPLY OF SWAMPSCOTT.

A 16-inch main 4,700 feet long has been laid from the corner of Ocean and Nahant streets in Lynn, through Ocean and New Ocean streets to the Swampscott line, for the purpose of improving the supply to the town of Swampscott. A contract for laying this main was made with C. M. Callahan on April 22, 1910. Work was begun at the Swampscott line on April 29. Pipe laying was completed on June 16 and the resurfacing of the trench on June 30. The new main was connected with the old 12-inch main at each end, and 11 wooden insulating joints were made on the line by the maintenance force.

The value of work done by contract was \$4,518.30. The whole cost of the work, including work done by the maintenance force and materials used, was \$14,009.70.

• NEW SUPPLY MAIN TO EAST BOSTON.

The East Boston low-service district includes a thickly settled residential district with a population of 56,230, together with much valuable wharf property along the water front. For the past forty years this district has been dependent for its water supply upon two mains which are laid under the bed of Chelsea Creek, a tidal arm of the ocean separating East Boston from the mainland of Chelsea. The creek at the location where the pipes are laid is about 1,500 feet wide at high water, while the low-water channel is about 300 feet wide. At the channel the pipes are buried several feet below the bed of the creek, but on the flats on either side the pipes are supported on piles just above the surface of the mud, and are exposed twice each day at low tide.

For the purpose of guarding against the interruption of the supply to the district by the breaking of these mains, a 36-inch main is now being laid in a different location. The new main connects

with existing 20-inch and 24-inch mains in Marginal Street, Chelsea, extends along the northerly shore of the creek about 3,800 feet to a point near the Chelsea Street Bridge leading to East Boston, where it turns easterly and crosses under the channel through a tunnel 504 feet long to the East Boston shore.

The new main is 30 inches in diameter for a distance of 729 feet from the connection with the old mains in Marginal Street to the corner of Shawmut and Essex streets. At this point the size of the pipe is increased to 36 inches in diameter, and a 36-inch branch is placed for future connection with the 42-inch main in Broadway, Chelsea. The 36-inch main extends easterly from this point through Essex and Highland streets and Congress Avenue, Marginal Street and Eastern Avenue to the Chelsea shaft of the tunnel under Chelsea Creek, a distance of 3,110 feet.

On account of the unstable nature of the ground the pipes are supported at the easterly end of this line for a distance of 1,700 feet upon a pile foundation, consisting of bents of 2 spruce piles capped with 10-inch x 10-inch spruce timber, the bents being spaced about 6 feet apart.

A contract for laying a portion of the pipe line in Chelsea was made with Michael Russo on August 10. Work was begun on August 15, and the contract was finished on December 8, at a cost of \$13,086.10.

At the crossing of Chelsea Creek a tunnel 504 feet long has been constructed under pneumatic pressure.

The tunnel section includes a vertical shaft at each side of the creek, 9 feet 4 inches outside diameter, with the top at elevation 14 on the Chelsea shore and at elevation 10 on the East Boston shore. The horizontal section of the tunnel, joining the shafts, is 400 feet in length, 8 feet 2 inches outside diameter, with the top 36 feet below mean low water at the Chelsea end, and is located about 25 feet down-stream from the westerly side line of the Chelsea Street Bridge. The shafts were constructed with 12-inch brick walls and the horizontal portion of the tunnel with 8-inch brick walls. The Chelsea shaft rises about 12 feet above the bed of the creek, and is protected by a steel casing which extends about 13 feet into the silt bottom of the creek. The East Boston shaft was sunk through the earth filling

back of the masonry sea wall, and is protected by a steel casing for a distance of 8 feet below the top. The axis of the horizontal section of the 36-inch pipe which is laid in the tunnel is 40 feet below Boston City Base at the Chelsea shaft.

The pipes are laid with a $\frac{1}{2}$ -inch opening between the end of the spigot and the bottom of the socket, and the joints are run solid with lead and calked both inside and outside after the pipe is laid. After the tunnel was excavated and lined the air pressure was removed, the 36-inch pipes are now being laid through the tunnel and the space between the pipes and the sides of the tunnel and shafts is being filled solid with Portland cement concrete. The tunnel section of the work is being done by day labor under the charge of Charles A. Haskin as superintendent.

The steam plant for operating the air compressors, hoists and electric lighting plant was set up on the Chelsea shore of the creek during the latter part of July, and the work of sinking the shaft was begun during the week ending August 13. After August 21, when the air lock was in place, the work was carried on continuously during twenty-four hours per day, with three shifts. While excavating the mud and silt just below the bed of the creek some inconvenience was experienced on account of gas, which entered the shaft and affected the eyes of the workmen.

The work of excavating and lining the shaft was completed about September 1. An air lock was then built at the entrance to the horizontal portion of the tunnel, and the small lock which had been used for sinking the shaft was removed. The excavation and lining of the horizontal portion of the tunnel progressed at the rate of about 5 feet per day. The air pressure maintained varied from 14 to 23 pounds per square inch, according to the stage of the tide in the creek above.

On October 13 a blow-out occurred about 150 feet from the Chelsea shaft at a point where a pile had been removed. As a result, the tunnel was flooded with water to a depth of about 4 feet. After the hole was stopped the water was pumped out, and the work proceeded without further mishap.

On the East Boston side of the creek the material excavated was hardpan containing boulders, which required some blasting, so that

the rate of progress was less than it had been in the sand and clay on the Chelsea side of the creek. A 2½-inch steel pipe was driven, during the week ending November 12, on the centre line of the tunnel near the East Boston end, from the surface of the ground to the centre of the tunnel, for use in supplying compressed air for sinking the East Boston shaft.

Work in the tunnel was discontinued on November 17, when steel sections of the East Boston shaft and the hoisting engine were set up on the East Boston side of the creek. On November 18 the work of excavating the East Boston shaft was begun, and on November 24 air pressure was applied.

An opening was made from the bottom of the shaft into the tunnel on December 3. All excavation and the brick lining for the tunnel were completed on December 6, and the air pressure was removed on the morning of December 9. A total of 104 linear feet of shaft and 400 feet of tunnel were built. The tunnel was cleaned out and plastered, and, after calking a few small leaks, was substantially water tight. At the end of the year 46.5 feet of 36-inch pipe had been laid in the East Boston shaft and the concrete masonry had been completed for a length of 38 feet. In the tunnel 160 feet of 36-inch pipe had been laid and the concrete masonry had been completed for a length of 157 feet.

The force employed on this work while working continuously under air pressure averaged about 15 men for each of the three shifts. After the air pressure was removed the work was carried on with three shifts working six days per week, the force employed averaging about 16 men per shift.

A 20-inch Venturi meter with 8-inch throat was installed by the maintenance force at the end of the line in East Boston, where connection was made with the Boston Water Works 30-inch main.

The cost of the work done on this new main to the end of the year was as follows:—

Section 37.

Pipes, valves and special castings,	\$22,092 42	
Laying pipes, including pipe-laying materials and earth excavation,	6,830 90	
Pile driving and timber foundation,	3,533 08	
Valve chambers and concrete backing for curves, .	579 00	
Work in connection with changes in underground structures,	2,357 71	
Additional expenses,	1,417 48	
	<hr/>	\$36,810 59

Section 38.

Pipes and special castings,	\$1,656 27	
Day work, labor,	16,607 20	
Day work, supplies and expenses,	14,977 03	
Additional expenses,	738 04	
	<hr/>	33,978 54
Engineering and preliminary, sections 37 and 38,		4,167 63
		<hr/>
Total,		\$74,956 76

PUMPING ENGINE FOR SOUTHERN HIGH SERVICE.

A contract for building and erecting a triple expansion, crank and fly-wheel engine, having a capacity of 40,000,000 gallons in twenty-four hours, was made with the Holly Manufacturing Company of Buffalo, on September 21, 1909, and the construction of the engine was begun at the shops of the contractor in the latter part of that year. The first shipment of parts of the engine arrived at the pumping station in the latter part of August, 1910, and the work of erection has been in progress since that date. At the close of the year the main parts of the engine were nearly all in place, and it appears probable that the engine will be ready for service on March 21, 1911, as specified in the contract.

This engine is to be used for pumping water for the southern high-service district, but it is located in the low-service station in space which was originally designed to be used for engines pumping to the highest portions of Newton, Brookline and West Roxbury.

On April 29 a contract was made with the Robb-Mumford Boiler Company of South Framingham for furnishing two vertical fire-tube boilers from designs made by F. W. Dean of Boston, mechanical

engineer. One of these boilers was delivered at the pumping station on December 29 and the other will be delivered early in January. Each boiler is of 300 nominal horse power, 9 feet $1\frac{7}{8}$ inches in diameter, and contains 484 No. 12 gage, 2-inch charcoal iron tubes 15 feet long.

A contract for constructing and erecting a fuel economizer, containing 144 cast-iron tubes 4 inches in diameter, was made on October 11 with the B. F. Sturtevant Company of Hyde Park for the sum of \$1,740. The economizer has been delivered at the station and is now being erected.

Grates for use with the boilers are to be furnished by the New England Roller Grate Company for \$225 each.

A steel plate smoke flue, to connect the new boilers with the economizer and chimney, has been ordered from the B. F. Sturtevant Company for the sum of \$536.

The work of building the concrete foundations for the engine and boilers, constructing a valve chamber 38 feet x 9 feet at the front of the pumping station to receive two 36-inch hydraulic lift valves, cutting out the opening in the engine room floor to receive the engine and the openings in the concrete foundation walls for the suction and delivery mains, has been done by the maintenance force of the department.

The foundation for the engine was built in June and consists of a block of concrete masonry 33 feet 8 inches long, 21 feet 8 inches wide and 7 feet 6 inches deep. The concrete rests upon a clayey hardpan. The iron bolts securing the engine to this foundation are attached to cast-iron washers 18 inches square, embedded in the concrete 5 feet 11 inches from the top of the foundation. The concrete was mixed in the proportion of 1 part cement, 3 parts sand and 6 parts broken stone, and large pieces of broken concrete and rock from the excavation were embedded in the foundation.

A foundation was also built for one of the boilers, that for the other having been constructed when the pumping station was built. This foundation was carried 13 feet 2 inches below the boiler room floor. The concrete was mixed in the proportion of 1 part cement, 6 parts sand and 12 parts broken stone for 6 feet above the bottom, and the upper 7 feet was made of 1 part cement, 2 parts sand and 6 parts stone.

HYDRO-ELECTRIC PLANT.

Specifications were prepared in May for the sale of the electrical energy to be developed at the Wachusett Dam at Clinton, and bids for the energy were received on June 15, but it was not until September 14 that a contract was made with the Connecticut River Transmission Company for the purchase of all the energy for a term of five years from July 1, 1911.

Proposals for the construction and installation of the hydro-electric machinery required for the development of the power were received on November 9, and a contract has been made with the S. Morgan Smith Company of York, Pa., for installing both the hydraulic turbines and the electric generators. The generators and other electrical equipment will be furnished under a subcontract by the Westinghouse Electric & Manufacturing Company of Pittsburgh, Pa.

A contract for furnishing a traveling crane for use in erecting and maintaining the machinery has been made with the Niles-Bement-Pond Company of Boston, and a contract for furnishing four 48-inch hydraulic lift valves has been awarded to the Fairbanks Company of Boston.

The completed plant is to include four 1,200 horse power hydraulic turbine units of the spiral case, horizontal shaft type, each directly coupled to a 1,000-kilowatt, 60-cycle, 3-phase, 13,800-volt, alternating current generator, together with two 90 horse power horizontal shaft turbines, each directly coupled to a 60-kilowatt direct current, 125-volt generator, to be used in exciting the main generators. It is expected that this plant will be completed in readiness for operation by July 1 of the coming year.

MISCELLANEOUS CONSTRUCTION.

The Coffin Valve Company, under a contract made May 17, has furnished five 36-inch hydraulic lift valves for \$1,272 each, for use in connection with the new pumping engine at Chestnut Hill, also seven 24-inch and two 16-inch screw lift valves for use with the pipe lines. Fourteen sets of steelwork for covering valve chambers have

been furnished by the James Russell Boiler Works for the sum of \$690, and four steel chambers for Venturi meter registers have been furnished by the Daniel Russell Boiler Works for \$175 each.

ENGINEERING.

The work of the engineering force in connection with construction has included the preparation of plans and specifications, and the superintendence of work which has been in progress under 25 separate contracts, aggregating about \$700,000. The principal items of work covered by these contracts have been the 60-inch pipe line and tunnel in Newton; the new pumping engine, boilers and accessories at the Chestnut Hill pumping station; the 36-inch pipe line and tunnel from Chelsea to East Boston; pipe lines in Arlington and Lynn, and a hydro-electric power plant at the Wachusett Dam. During the year investigations have been made and estimates prepared relative to furnishing a supply of water from the Metropolitan Works to the towns of Peabody, Wakefield and Hyde Park.

MAINTENANCE.

RAINFALL AND YIELD.

The rainfall on the Wachusett watershed was 37.85 inches and on the Sudbury watershed 35.64 inches. In each case the amount is the mean of observations made at four stations. The rainfall for the past year on the Sudbury watershed has been less than that in any previous year during the thirty-six years covered by the records, with the exception of 1883, when it was 32.78 inches, and the rainfall of the past three years has been but 113.54 inches, which is less than that for any corresponding length of time since the records were commenced.

The daily average yield of the Wachusett watershed was but 828,000 gallons per square mile per day, which is less than any previous record, and 29 per cent. less than the average yield during the previous thirteen years. The average daily yield per square mile during the last six months of the year was but 201,000 gallons, or 16 per cent. below the lowest previous record for the watershed, and 65 per cent. below the average yield of the driest six months during the past fourteen years.

Statistics relating to the rainfall and yield of watersheds may be found in Appendix No. 2, tables Nos. 1 to 8.

STORAGE RESERVOIRS.

The quantity stored in all the storage reservoirs on January 1, 1910, was 62,101,500,000 gallons. There was a loss of 543,400,000 gallons during the first five days of the year, after which time there was a practically continuous gain until the first of April, when the quantity stored in all the reservoirs was 77,692,400,000 gallons. The quantity stored was reduced to 76,719,700,000 gallons on April 18, after which time it was increased until May 10, when it was 77,826,500,000 gallons. It fell to 76,585,000,000 gallons on June 5, and rose to 77,676,600,000 gallons on June 19, after which time there was a practically continuous loss of storage until the end of the year.

The following table gives the quantity of water stored in the storage reservoirs at the beginning of each month:—

Quantity of Water stored in Wachusett Reservoir, and in Reservoirs on Sudbury and Cochituate Watersheds, at the Beginning of Each Month.

DATE.	In Wachusett Reservoir (Gallons).	In Sudbury Reservoir and Frammingham Reservoir No. 3 (Gallons).	In All Other Storage Reservoirs (Gallons).	Total (Gallons).
1910.				
January 1,	48,667,800,000	7,806,400,000	5,627,300,000	62,101,500,000
February 1,	52,256,200,000	7,857,400,000	6,258,900,000	66,372,500,000
March 1,	56,059,900,000	8,237,100,000	6,632,400,000	70,929,400,000
April 1,	63,252,000,000	8,046,800,000	6,393,600,000	77,692,400,000
May 1,	63,612,300,000	8,308,300,000	5,980,400,000	77,901,000,000
June 1,	62,932,400,000	7,933,900,000	6,196,300,000	77,062,600,000
July 1,	62,812,600,000	7,918,800,000	5,841,400,000	76,572,800,000
August 1,	59,194,200,000	7,962,900,000	5,685,300,000	72,842,400,000
September 1,	56,136,200,000	7,906,200,000	5,611,500,000	69,653,900,000
October 1,	53,360,500,000	7,831,100,000	5,665,700,000	66,857,300,000
November 1,	50,146,000,000	7,761,200,000	5,613,700,000	63,520,900,000
December 1,	48,175,400,000	7,808,500,000	5,700,700,000	61,684,600,000
1911.				
January 1,	45,610,400,000	7,890,400,000	5,826,200,000	59,327,000,000

Wachusett Reservoir and Dam. — At the beginning of the year the water in this reservoir was 12.91 feet below high-water mark, and the reservoir contained 48,667,800,000 gallons of water. The low-water mark of the early part of the year was on January 6, when the elevation of the reservoir was 381.70. After January 18 there was an almost continuous rise in the elevation of the water level of the reservoir until about April 1, when it was 393.72, or 1.28 feet below high-water mark. From this time until the latter part of June the reservoir surface remained at about the same elevation, the highest point being reached on May 8, when it was 394.25. After June 20 the reservoir surface lowered at the rate of a little more than 2 feet per month until the end of the year, when it stood at elevation 379.35, and contained 45,610,400,000 gallons of water, showing a net loss in storage during the year of 3,057,400,000 gallons.

The average daily quantity discharged from the reservoir into the river, in accordance with the requirements of section 4 of chapter 488 of the Acts of the year 1895, was 2,106,000 gallons per day.

As in previous years, the action of the waves on the shores of the reservoir has made necessary the removal of soil, in order to prevent its being washed into the reservoir. Between Hastings Cove in Boylston and Pine Hill in West Boylston, on the south shore, and along the north shore at Beaman Hill in West Boylston, the soil has been removed at points where necessary for a total distance of 5,526 feet, in widths varying from 10 to 25 feet. The aggregate area from which soil was removed was 1.75 acres, as compared with 1.46 acres in 1909. The amount expended for this work was \$907.29.

The action of the flood waters during the spring washed out the gravel bank which formed the easterly shore at the head of the Stillwater Basin. For a distance of 300 feet the bank has been regraded and reinforced with riprap formed with stones and gravel taken from the bed of the basin. The amount expended for this work was \$258.36.

The riprap on the easterly shore of the reservoir immediately above the dam has been repaired and reinforced with heavier stones for a distance of 1,250 feet, at a cost of \$115.16.

The paving at the outlet of the culvert which carries a small brook under Beaman Street into the Stillwater Basin has been relaid where damaged by the wearing away of the shore.

Tree stumps, roots, logs and miscellaneous débris brought into the reservoir by the flood waters in the spring, or unearthed by wave action on the shores, have been collected and burned.

Two pot holes, located near the westerly end of the North Dike, between the Clinton and West Boylston highway and the Worcester, Nashua & Portland Railroad, which became stagnant pools when the reservoir was full, have been improved in appearance, one by filling with earth to a level about one foot above high water in the reservoir and the other by cleaning the shores.

The standing and rowen grass on about 350 acres of land was sold for \$2,605.75. About 6.4 acres of grass land below the dam and 17.6 acres on the back slope of the easterly portion of the North Dike have been fertilized with 620 cubic yards of sludge collected from the settling tanks at the Clinton sewerage filter-beds. The cost of hauling and spreading this material was \$643.82.

The motor scow, which was built in 1909, has been used nearly every day, when the reservoir was not covered with ice, for transporting men, tools and materials in connection with the maintenance work, and has given excellent satisfaction.

The structures and grounds at the dam are in good condition. The outside and inside woodwork of both the upper and lower gate-chambers, the iron fences and railing on and about the dam, and the cast-iron and steel flashboard supports on the dam have been painted. A fountain has been installed in the pool below the dam, from which is discharged a portion of the water which the law requires shall be discharged into the river, thus adding a beautifying feature to the grounds.

The old dam at the outlet of Middle Waushacum Pond has been replaced with a concrete structure 26½ feet long and 8 feet high, having a spillway 12 feet long fitted to receive stop-planks, and a 3 foot by 3½ foot sluiceway fitted with a sluice gate.

The brook channel below this dam has been straightened, cleaned and improved for a distance of about 375 feet.

All the buildings at the storage yard near the Wachusett Dam, also the exterior of six houses owned by the Board located near the Clinton sewerage filter-beds, have been given two coats of paint.

Sudbury Reservoir. — All the water supplied to the Metropolitan District from the Wachusett Reservoir passes through this reservoir,

and its level is controlled by the manipulation of the gates controlling the flow through the Wachusett Aqueduct. The surface of the reservoir did not fall below the crest of the dam during the year, and all the water drawn from this reservoir into Framingham Reservoir No. 3 passed over the crest of the dam, except from April 15 to May 7, when the flashboards were on the whole length of the crest and the water was drawn through one of the waste gates.

The Bigelow house on Farm Street, Marlborough, occupied by one of the section men, has been repaired and painted. In order to obtain a permanent supply of water for the use of the section man living in the Cratty house, at Fayville, a well has been dug near the shore of the reservoir and connected with the house by a 1½-inch cement-lined pipe 215 feet in length. Some grading has been done on the road, following the north shore of the reservoir, from the dam around Pine Hill to Parmenter Street, and two culverts have been constructed in connection with this work. The reservoir and grounds have received the customary care and attention and are in good condition.

Framingham Reservoir No. 3. — The water in this reservoir was maintained within about 2 feet of the stone crest of the overflow. Some water was wasted into Framingham Reservoir No. 1 during the first three days of March, and also during the latter part of March and the first part of April.

Seven horizontal joints and a portion of the vertical joints in the face of the overflow of the dam, and ten horizontal and twenty-eight vertical joints on the down-stream face of the gate-house over the 48-inch pipes leading to Framingham Dam No. 1, have been cut out and repointed with Portland cement mortar. The mortar in many of the joints was found to be disintegrated to a considerable depth, necessitating cutting out the joints to depths of from 8 to 18 inches.

The entrance driveway at the dam has been extended to the new location of Worcester Street. The area between the old and new location of the street has been graded and covered with loam, and a gravel sidewalk has been built bordering on the street.

Framingham Reservoirs Nos. 1 and 2. — No water was drawn from these reservoirs during the year for the use of the Metropolitan District.

Ashland, Hopkinton and Whitehall Reservoirs. — These reservoirs

have not been drawn upon for the supply of the District during the year, and have remained at or near high-water mark. The grounds have received the usual care and are in good condition. The attendant's house at Hopkinton Reservoir has been repaired and the exterior painted. At Whitehall Reservoir the upper portion of the temporary dam built by the city of Boston in 1897, for the purpose of providing additional storage, has been removed, as it had become badly decayed and is no longer required.

Farm Pond. — No water was drawn from the pond for use in the Metropolitan District; none was wasted from the pond and none run into it from the Sudbury River. The town of Framingham drew the greater portion of its supply from the filter-gallery alongside the pond, but during 258 days of the year drew a portion of its supply directly from the Sudbury Aqueduct. The total quantity used in the town was 228,700,000 gallons, of which 38,100,000 gallons were drawn directly from the Sudbury Aqueduct.

Lake Cochituate. — The water in the lake was at elevation 138.76, or 5.6 feet below high water, at the beginning of the year. It rose to elevation 143.33 on February 10, when the waste gate was opened and the water prevented from rising. About the middle of April the quantity wasting was increased, and the lake surface lowered about 2 feet, and in the latter part of June and early in July the lake was lowered about 18 inches more, to elevation 139.50, for the purpose of facilitating the construction of a drainage system near the lake. The water was maintained at this elevation until the first of November, after which time it rose slowly and stood at elevation 141.17 at the end of the year. No water was drawn from the lake for the use of the Metropolitan District during the year.

The coping of the retaining wall bordering the driveway from Lake Avenue to the effluent gate-house, a distance of about 700 feet, has been reset, and the upper part of the retaining wall along Lake Avenue, for a distance of 400 feet west of the entrance driveway, relaid. The iron and wood work at the outlet dam, and the exterior of the roof and ironwork in the interior of the effluent gate-house, have been painted.

A four-strand wire fence, 281 feet long, has been built on the line between property of Edward Hammond and the Commonwealth on the east side of the lake, near Camp Tray. Twenty-nine standard

land bounds have been set to define land of the Commonwealth along Course Brook north of Speene Street.

Considerable work was done during the winter months in cleaning up woodland around the lake by removing dead and broken limbs, cutting brush, thinning out trees, and in clearing a strip from 4 to 5 feet in width through the woods along property lines.

DIVERSION OF SURFACE DRAINAGE OF THE VILLAGE OF COCHITUATE, FROM LAKE COCHITUATE INTO THE SUDBURY RIVER.

The surface drainage from an area of 140 acres now draining through Snake Brook into Lake Cochituate, on which there is a population of 707, is to be diverted into a system of open and covered drains, by which it is to be carried outside the watershed and discharged into Bannister's Brook. The outlet of the system is at an old mill-pond located north of the County Road and west of Speene Street, in Framingham. The open channel extends southerly from this point along Bannister's Brook, crossing the County Road, then turning easterly, following an old channel known as Richardson's drain, crossing Speene Street near the Natick-Framingham boundary line and the Saxonville Branch of the Boston & Albany Railroad, through land of the Commonwealth to a point near Lake Avenue in Natick, 400 feet west of the culvert connecting the northern and middle divisions of Lake Cochituate.

The length of this open channel is 5,958 feet, including 82 feet of covered concrete culvert at two street crossings. The channel is 12 inches wide at the bottom, with side slopes of 2 horizontal to 1 vertical, and is constructed with a plank bottom formed by spiking two 2-inch x 7-inch spruce planks side by side on 3-inch x 4-inch sills, 2 feet long, spaced 4 feet on centres, with side pieces of 6-inch x 6-inch spruce cut on the diagonal and rabbetted so as to lay 1 inch over the bottom planks. These side pieces form a footing for a strip of cobblestone paving $1\frac{1}{2}$ feet wide on the slope, excepting at the outside of all curves, where the paving is $4\frac{1}{2}$ feet wide. The slopes for a distance of 3 feet above the paving are covered with coarse gravel, excepting at the outside of curves.

The concrete-covered drain extends from the upper end of the open channel through Lake Avenue, in Natick, Pond Street, in Wayland, and land of the Commonwealth on the southerly side of Pond Street,

to Hammond's Brook, a distance of 3,454 feet. This drain is 36 inches wide x 33 inches high, and is constructed of Portland cement concrete mixed in the proportion of 1 part cement, $2\frac{1}{2}$ parts sand and 5 parts gravel.

At the crossing of the culvert connecting the northerly and middle divisions of Lake Cochituate a 36-inch cast-iron pipe is used in place of the concrete structure. This pipe was laid by the maintenance force in 1909, in order to take advantage of the unusually low level of the water in the lake.

A 24-inch vitrified pipe extends from the inlet chamber at Hammond's Brook through land of the Commonwealth, a distance of 957 feet, to Main Street, in Wayland. Nine manholes were built on the line of the concrete and pipe drains and 14 catch basins were built to receive the surface drainage at different points. In connection with the catch basins there were laid 167.5 feet of 18-inch and 351.4 feet of 12-inch vitrified pipe.

Contract work was begun July 12, the open channel was completed on December 3, and at the close of the year about two weeks' work remained to complete the drains in readiness for use. The average force employed by the contractor on the work was 64 men and 7 horses. The largest force employed was during the week ending September 10, when 134 men and 10 horses were at work.

The value of the work done under this contract to December 31 was \$30,674.52, and the total cost of the whole work will be about \$32,000.

SOURCES FROM WHICH WATER FOR THE SUPPLY OF THE METROPOLITAN DISTRICT HAS BEEN TAKEN.

An average of 103,146,200 gallons of water per day was drawn from the Wachusett Reservoir through the Wachusett Aqueduct into the Sudbury Reservoir. For the use of the Metropolitan District an average of 28,974,000 gallons per day was drawn from the Sudbury Reservoir through the Weston Aqueduct and an average of 85,033,000 gallons per day from Framingham Reservoir No. 3 through the Sudbury Aqueduct.

The drainage area of Spot Pond furnished 57,000 gallons of water per day.

AQUEDUCTS.

The *Wachusett Aqueduct* was in use 8,163 hours and 20 minutes, equivalent to 340.1 days, during the year. The aqueduct was not cleaned during the year.

The *Sudbury Aqueduct* was in continuous service the entire year, the daily flow to Chestnut Hill Reservoir averaging 85,033,000 gallons. The joints in the brick masonry and in the sandstone trimmings of the superstructures of Bacon's and Fuller's waste-weirs have been repointed with Portland cement mortar, also the joints in the stone masonry of the culverts numbered 16, 34, 39, 40 and 41. The joints in the masonry substructure of Clark's waste-weir and of the stone walls on both sides of the channel leading to Culvert No. 34 were also repointed.

At Echo Bridge, over the Charles River, the face of the ledge on the east side of the river at the foot of the large arch had commenced to disintegrate, and thus render unsafe the supports for the platform used by the public when listening to the echo. In order to prevent further disintegration of the rock a rubble wall about 5 feet high, with an average thickness of $3\frac{1}{2}$ feet at the bottom, has been built, covering the whole face of the ledge under the arch. About 13 cubic yards of material were used in the construction of this wall.

The leakage through joints and cracks in the masonry of this bridge is increasing from year to year, due to the gradual widening of the cracks by temperature changes and the action of ice during the winter, and extensive repairs similar to those made a few years ago at the Waban Bridge will soon be required.

The exterior of the store-house near the west siphon chamber, the floor grating in Fuller's waste-weir, the iron railing and roof flashing at the east siphon chamber, the railings, beams and other ironwork in the stairways leading to the top of Echo Bridge and to the platform under the large arch, and the manhole covers along the aqueduct line have been painted, and the stairways on the embankments of the east and west siphon chambers and on that leading to the top of Echo Bridge have been oiled. A new right-of-way has been acquired from Eliot Street, in Natick, to Bacon's waste-weir, to be used in place of the old inconvenient right-of-way from Woodland Street.

No water was drawn through the *Cochituate Aqueduct* for the use of the Metropolitan District during the year. The joints in the stone masonry of the following culverts have been cut out and repointed: Culvert west of Croton Street, in Wellesley; culvert east of Washington Street, at Newton Lower Falls; culvert on the west side of Woodward Street, in Newton, and the first culvert east of Chestnut Street, in Newton.

The *Weston Aqueduct* was in continuous service throughout the year, the daily average flow being 28,974,000 gallons. The aqueduct was not cleaned during the year. The siphon pipe over the Sudbury River, the iron and wood work in the gaging and siphon chambers and the manhole covers have been painted. At several points along the line of the aqueduct the slopes of the embankments have been graded and seeded.

PUMPING STATIONS.

Seventy-four per cent. of the water supplied to the Metropolitan District has been pumped at the two stations at Chestnut Hill Reservoir, and the remainder has been delivered by gravity. The total quantity pumped at all the stations was 34,108,790,000 gallons, which was 4.62 per cent. less than during the preceding year. The cost of operating the stations was \$101,996.34, equivalent to \$2.99 per million gallons pumped, which was almost exactly the same as the corresponding amount for the year 1909. The average cost of raising 1,000,000 gallons of water 1 foot high at all the stations was \$0.0342, which is slightly less than the cost during the previous year. Coal for use at the several stations has been purchased as follows:—

BY WHOM FURNISHED.	GROSS TONS.					Cost per Gross Ton, in Bins. ¹
	Chestnut Hill High-service Station.	Chestnut Hill Low-service Station.	Spot Pond Station.	Arlington Station.	West Roxbury Station.	
Gorman-Leonard Coal Company, bituminous,	1,015.09	-	-	-	-	\$4 09
Gorman-Leonard Coal Company, bituminous,	-	569.60	-	-	-	4 01
Spring Coal Company, bituminous,	2,787.74	-	-	-	-	3 96
Spring Coal Company, bituminous,	-	1,508.35	-	-	-	3 79
C. W. Claffin & Co., buckwheat anthracite,	268.78	-	-	-	-	2 80
C. W. Claffin & Co., buckwheat anthracite,	903.40	-	-	-	-	2 75
C. W. Claffin & Co., buckwheat anthracite,	-	115.92	-	-	-	2 62
C. W. Claffin & Co., buckwheat anthracite,	-	813.67	-	-	-	2 58
New England Coal & Coke Company, bituminous,	-	-	587.77	-	-	4 83
New England Coal and Coke Company, bituminous,	-	-	58.34	-	-	4 60
Locke Coal Company, bituminous,	-	-	90.07	-	-	4 60
Locke Coal Company, screenings,	-	-	149.06	-	-	2 50
Joseph Butler, screenings,	-	-	69.30	-	-	2 50
New England Coal and Coke Company, bituminous,	-	-	-	170.00	-	4 31
New England Coal and Coke Company, bituminous,	-	-	-	30.09	-	4 08
New England Coal and Coke Company, bituminous,	-	-	-	124.42	-	3 89
Philadelphia and Reading Coal and Iron Company, screenings,	-	-	-	117.50	-	2 68
Metropolitan Coal Company, furnace,	-	-	-	-	20.04	6 27
Roxbury Coal Company, furnace,	-	-	-	-	6.77	5 88
Metropolitan Coal Company, pea,	-	-	-	-	181.84	5 04
Roxbury Coal Company, buckwheat anthracite,	-	-	-	-	104.02	4 37
Roxbury Coal Company, buckwheat anthracite,	-	-	-	-	1.86	3 98
Total gross tons, bituminous,	3,802.83	2,077.95	736.18	324.51	-	-
Total gross tons, anthracite,	1,172.18 ²	929.59 ²	-	-	314.53	-
Total gross tons, anthracite screenings,	-	-	218.36	117.50	-	-
Average price per gross ton, bituminous,	\$3 99	\$3 85	\$4 82	\$4 13	-	-
Average price per gross ton, anthracite,	2 76 ²	2 59 ²	-	-	\$4 91	-
Average price per gross ton, anthracite screenings,	-	-	2 50	2 68	-	-

¹ Includes cost of unloading coal from cars and all expenses incidental to storage of the coal.

² Buckwheat.

The contracts which have been made for bituminous coal have specified that the coal should contain approximately 14,700 British thermal units per pound, 18 to 20 per cent. volatile matter, and not more than 7 per cent. of ash and 1 per cent. of sulphur. Payments for the coal are now made on the basis of the price bid, corrected for variations in heating value and per cent. of ash, as determined

by testing samples of the coal delivered, an addition being made in cases where the number of British thermal units exceeds 14,700 and a deduction when the number falls below 14,600. A deduction is also made when the moisture in the coal exceeds 3 per cent. These requirements are more stringent than those in force during previous years, and the quality of the coal now obtained is better than it was a few years ago.

The following table shows the results of tests made of coal burned at the Water Works pumping stations during the past year:—

KIND OF COAL.	Number of Samples tested.	British Thermal Units.	Percentage of Volatile Matter.	Percentage of Ash.	Percentage of Moisture.
Vulcan,	58	14,474	20.95	8.16	2.54
Beaver Run,	26	14,722	17.40	6.70	3.15
New River,	7	14,867	21.18	5.27	1.83
Pocahontas,	6	14,879	19.55	5.16	2.33
Georges Creek,	6	14,469	18.88	7.71	2.59
Davis,	2	14,517	17.12	7.08	2.48
Nan-ty-glo,	1	14,982	21.56	5.14	3.24
Carbon,	1	14,268	18.10	9.24	4.17

Chestnut Hill High-service Station.

At this station water is pumped for use in the high-service district of Boston, the city of Quincy and the towns of Watertown, Belmont and Milton.

The following are the statistics relating to operations at this station:—

	Engines Nos. 1 and 2.	Engine No. 3.	Engine No. 4.	Totals for Station.
Total quantity pumped (million gallons),	1,377.71	228.67	10,824.70	12,431.08
Daily average quantity pumped (gallons),	3,775,000	626,000	29,657,000	34,058,000
Total coal used (pounds),	2,168,024	247,119	8,467,877	10,883,020
Gallons pumped per pound of coal,	635.47	925.34	1,278.33	1,142.25
Average lift (feet),	119.67	129.88	130.58	129.36
Cost of pumping:—				
Labor,	\$4,005 32	\$538 35	\$16,990 32	\$21,533 99
Fuel,	3,605 96	411 62	14,209 11	18,226 69
Repairs,	337 91	42 36	1,336 95	1,717 22
Oil, waste and packing,	99 32	13 35	421 33	534 00
Small supplies,	66 32	8 91	281 31	356 54
Totals,	\$8,114 83	\$1,014 59	\$33,239 02	\$42,368 44
Cost per million gallons pumped,	\$5.8900	\$4.4370	\$3.0710	\$3.4080
Cost per million gallons raised 1 foot high, . . . . .	.0492	.0342	.0235	.0263

The daily average quantity pumped was less than the corresponding quantity for the previous year by 2,750,000 gallons, or 7.47 per cent.

The cost of operating the station was \$4,110.21 less than for the previous year, due largely to the reduction in the quantity pumped.

Chestnut Hill Low-service Station.

The daily average quantity pumped at this station was less by 2,161,000 gallons, or 4.11 per cent., than the corresponding amount for the previous year.

The following are the statistics relating to operations at this station:—

	Engines Nos. 5, 6 and 7.
Total quantity pumped (gallons),	18,394,520,000
Daily average quantity pumped (gallons),	50,396,000
Total coal used (pounds),	7,122,390
Gallons pumped per pound of coal,	2,582.63
Average lift (feet),	49.08

Cost of pumping:—

Labor,	\$19,675 97
Fuel,	10,952 56
Repairs,	1,525 11
Oil, waste and packing,	472 54
Small supplies,	363 89

Total for station,	\$32,990 07
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Cost per million gallons pumped,	\$1.7930
Cost per million gallons raised 1 foot high,0365

The work of building foundations for the new engine and boilers which are being installed at this station has been in progress during the year. A description of this work will be found in this report under the head of "Construction."

Spot Pond Pumping Station.

The following are statistics relating to operations at this station:—

Total quantity pumped (gallons),	2,752,110,000
Daily average quantity pumped (gallons),	7,540,000
Total coal used (pounds),	2,413,914
Gallons pumped per pound of coal,	1,140.10
Average lift (feet),	130.92
Engine No. 8 operated (hours),	161
Engine No. 9 operated (hours),	3.218
Quantity pumped by Engine No. 8 (gallons),	70,130,000
Quantity pumped by Engine No. 9 (gallons),	2,681,980,000

Cost of pumping:—

Labor,	\$8,779 04
Fuel,	4,191 43
Repairs,	199 22
Oil, waste and packing,	249 39
Small supplies,	203 39
Total for station,	<hr/> \$13,622 47
Cost per million gallons pumped,	\$4.9500
Cost per million gallons raised 1 foot high, . . . . .	.0378

The quantity of water pumped at this station was 2.2 per cent. greater, while the total cost of operating the station was \$426.39, or 3 per cent. less than during the previous year. The reduction in cost was due to the fact that but \$199.22 were expended for repairs during the past year, as compared with \$686.99 during 1909. The cost per million gallons pumped to the reservoir was \$4.95, as compared with \$5.216 in 1909.

Arlington Pumping Station.

At this station was pumped all the water supplied to the town of Lexington, to the high-service district of the town of Arlington and to a few houses in the town of Belmont.

The following are the statistics relating to operations at this station:—

Total quantity pumped (gallons),	282,530,000
Daily average quantity pumped (gallons),	774,000
Total coal used (pounds),	999,115
Gallons pumped per pound of coal,	282.78
Average lift (feet),	285
Engine No. 10 operated (hours),	6,295
Engine No. 11 operated (hours),	220
Quantity pumped by Engine No. 10 (gallons),	275,440,000
Quantity pumped by Engine No. 11 (gallons),	7,090,000

Cost of pumping:—

Labor,	\$5,029 26
Fuel,	1,658 48
Repairs,	294 29
Oil, waste and packing,	101 45
Small supplies,	300 04
Total for station,	<hr/> \$7,383 52
Cost per million gallons pumped,	\$26.1340
Cost per million gallons raised 1 foot high, . . . . .	.0917

There was an increase of 17.08 per cent. in the quantity pumped, and a decrease of \$442.80, or 5.66 per cent., in the cost of operating the station, as compared with the previous year.

The efficiency of the plant has been improved by the installation of a feed-water heater which had been used previously at the Chestnut Hill station.

West Roxbury Pumping Station.

At this station water was pumped for supplying the higher portions of West Roxbury and Milton.

The following are the statistics relating to operations at this station:—

Total quantity pumped (gallons),	248,551,000
Pumps operated 7,654 hours; average, 21 hours per day.	
Daily average quantity of water pumped (gallons),	681,000
Daily average quantity of coal consumed (pounds),	1,913
Gallons pumped per pound of coal,	355.92
Average lift (feet),	134

Cost of pumping:—

Labor,	\$3,775 22
Fuel,	1,553 38
Repairs,	211 87
Oil, waste and packing,	41 06
Small supplies,	50 31

Total for station,	\$5,631 84
------------------------------	------------

Cost per million gallons pumped,	\$22.6590
--	-----------

Cost per million gallons raised 1 foot high,1691
--	-------

The quantity pumped was 18.95 per cent. greater while the cost of operating the station was less by \$744.63, or 11.68 per cent., than for the previous year. The cost per million gallons pumped was reduced from \$30.52 to \$22.66. This result was very largely due to the use of a fuel of lower cost and to the more efficient operation of the machinery.

CONSUMPTION OF WATER.

The daily average quantity of water consumed in the 18 municipalities supplied from the Metropolitan Water Works during the year 1910, as measured by Venturi meters, was 112,092,100 gallons, equal to 110 gallons per capita in the district supplied. In

addition to the above, 85,400 gallons daily were supplied to the United States Government reservation on Peddock's Island, and 16,500 gallons daily to a small portion of the town of Saugus. The daily average quantity supplied to the Metropolitan Water District, as determined by pump measurement and by the flow in the Weston Aqueduct, and the estimated yield of Spot Pond, was 113,880,000 gallons, equal to 111 gallons per inhabitant. The excess difference of 1,686,000 gallons per day between the quantity delivered by the aqueducts and that measured by meters to the several municipalities is due to difference in methods of measurement, to leakage from the Metropolitan Water Works reservoirs and pipes, and to the use of water at the Chestnut Hill and Spot Pond pumping stations.

The daily average consumption of water in each of the cities and towns supplied from the Metropolitan Works during the years 1909 and 1910, as measured by meters, was as follows:—

	Estimated Popula- tion, 1910.	DAILY AVERAGE CONSUMPTION.					
		1909.		1910.		In- crease in Gallons.	De- crease in Gallons.
		Gallons.	Gallons per Capita. ¹	Gallons.	Gallons per Capita.		
Boston, . . .	674,400	94,029,900	143	87,346,700	130	—	6,683,200
Somerville, . . .	77,640	6,331,000	83	6,189,500	80	—	141,500
Malden, . . .	44,730	1,848,500	43	1,874,400	42	25,900	—
Chelsea, . . .	32,540	2,869,400	89	2,834,500	87	—	34,900
Everett, . . .	33,710	2,641,300	80	2,575,600	76	—	65,700
Quincy, . . .	32,870	2,919,000	91	2,891,900	88	—	27,100
Medford, . . .	23,330	1,732,300	77	1,422,400	61	—	309,900
Melrose, . . .	15,790	962,300	62	1,005,700	64	43,400	—
Revere, . . .	18,500	1,250,700	72	1,313,400	71	62,700	—
Watertown, . . .	12,960	755,300	60	880,800	68	125,500	—
Arlington, . . .	11,270	861,300	79	938,200	83	76,900	—
Milton, . . .	7,970	313,200	40	309,200	39	—	4,000
Winthrop, . . .	10,290	877,600	91	649,500	63	—	228,100
Stoneham, . . .	7,130	575,200	82	650,800	91	75,600	—
Belmont, . . .	5,800	310,100	58	329,500	59	19,400	—
Lexington, . . .	4,440	329,400	76	345,500	78	16,100	—
Nahant, . . .	2,100	124,400	60	121,700	58	—	2,700
Swampscott, . . .	6,960	388,200	56	412,800	59	24,600	—
District, . . .	1,022,230	119,119,100	119	112,092,100	110	—	7,027,000

¹ The populations for 1909 were revised after the Census of 1910 became available, and consequently the per capita figures differ from those published in 1909 report.

The consumption in the several districts was as follows:—

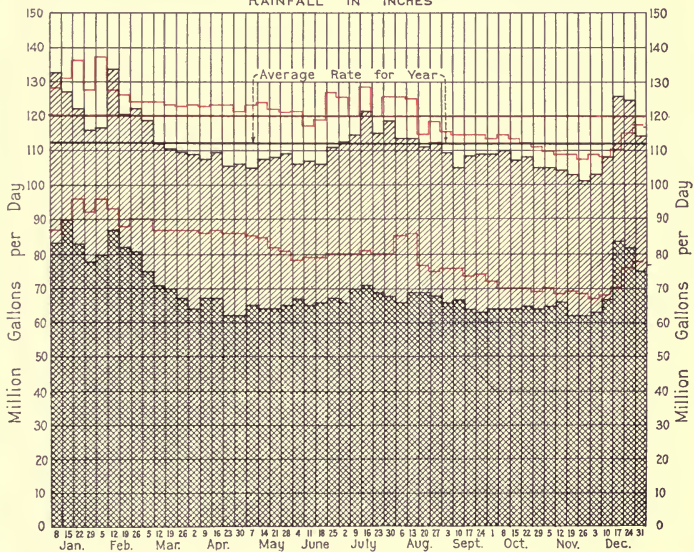
	Gallons per Day. 1910.	Decrease (Gallons per Day).	Percent- age of Decrease.
Southern low-service district, embracing the low-service district of Boston, with the exception of Charlestown and East Boston, . .	44,667,600	3,668,000	7.59
Northern low-service district, embracing the low-service districts of Somerville, Chelsea, Malden, Medford, Everett, Arlington, Charlestown and East Boston,	26,032,400	499,100	1.88
Southern high-service district, embracing the high-service districts of Boston, Quincy, Watertown, and portions of Belmont and Milton,	32,644,400	2,985,000	8.38
Northern high-service district, embracing Melrose, Revere, Winthrop, Swampscott, Nahant and Stoneham, and the high-service districts of Somerville, Chelsea, Malden, Medford, Everett and East Boston,	7,292,600	101,200	1.37
Southern extra high-service district, embracing the higher portions of West Roxbury and Milton,	681,000	108,500 ¹	18.95 ¹
Northern extra high-service district, embracing Lexington and the higher portions of Arlington and Belmont,	774,100	117,800 ¹	17.95 ¹
Totals,	112,092,100	7,027,000	5.90

¹ Increase.

The daily average quantity of water used in the District was 13,332,100 gallons less than during the year 1908. In the cities of Boston and Medford and the town of Winthrop a large reduction in the use of water has been accomplished during the past year by the introduction of meters. The reduction in these places, together with Melrose, in which meters were introduced in 1906 and 1907, illustrates very forcibly the saving which has been accomplished largely by the introduction of meters:—

CITY OR TOWN.	Popu- lation, 1910.	PER CAPITA CONSUMPTION (GALLONS).			EQUIVA- lent Saving in Gallons per Day.	METERS IN USE.	
		1907.	1910.	Reduction in Three Years.		Jan. 1, 1907.	Jan. 1, 1910.
Boston,	674,400	157	130	27	18,208,800	5,090	12,100
Medford,	23,330	105	61	44	1,026,520	449	2,594
Melrose,	15,790	118	64	54	852,660	132	3,510
Winthrop,	10,290	117	63	54	555,660	45	1,533
Totals,	723,810				20,643,640	5,716	19,737

The diagram facing this page shows graphically the average daily consumption and the rate of consumption between the hours of 1 and 4 A.M. in the district supplied by the Metropolitan Works for



Average Rate of Consumption for each week, thus.....
 " " " " between 1 and 4 A.M. for each week, thus.....
 Averages in 1909 shown in Red.

each week during the years 1909 and 1910. The amount of rainfall and the average temperature for each week, as observed at the Chestnut Hill Reservoir, are also shown. It will be noted that an increase or decrease in the daily consumption from week to week is coincident with an almost equal reduction in the rate of use between midnight and 4 A.M., indicating that the increase or decrease is due to a waste of water which was continuous throughout the twenty-four hours, and not due to a reduction in use during the hours when the greatest use should take place. Although the consumption, as shown by the diagram, varied from 102,000,000 to 136,000,000 gallons per day during several weeks of the two years, the difference between the night rate and the average daily rate for the corresponding week is shown to have been between 40,000,000 and 45,000,000 gallons, indicating that the changes in consumption are due to changes in the amount wasted rather than in the amount used. In the city of Boston a reduction of 23 gallons per capita has been made in two years, but the fact that in some districts of the city the rate of consumption still remains very high is proof that the further introduction of meters and a careful inspection for leaks in street mains will undoubtedly result in a considerable further lowering of the per capita rate.

The use in the several districts into which Boston is subdivided for purposes of measurement was, in 1908 and 1910, as follows:—

	Population, 1910.	DAILY AVERAGE CONSUMPTION (GALLONS).		GALLONS PER CAPITA.	
		1908.	1910.	1908.	1910.
Southern low-service includes business, residential and manufacturing districts in city proper, South Boston, Roxbury and Dorchester,	350,110	51,313,600	44,667,600	148	128
Southern high-service includes business and residential districts in city proper and residential districts in Roxbury, Dorchester and West Roxbury, . . .	211,100	30,112,400	27,077,600	158	128
Charlestown includes greater portion of Charlestown,	40,320	7,749,100	7,552,700	195	187
East Boston includes all of East Boston except Breed's Island,	56,230	7,278,300	6,172,600	140	110
Brighton high-service, residential district,	11,100	1,299,100	1,192,200	135	107
West Roxbury high-service, residential district,	5,010	599,000	655,500	131	131
Breed's Island, residential district, . . .	530	27,200	28,500	60	54
	674,400	98,379,300	87,346,700	153	130

Estimated population in 1908, 643,810.

Metering of Service Pipes.

On December 31, 1910, the cities of Boston and Quincy and the town of Revere were the only municipalities which had not complied with chapter 524 of the Acts of 1907 relative to the metering of service pipes. This Act provides that on and after January 1, 1908, all cities and towns which derive their water from the Metropolitan Works shall equip all new service pipes with water meters, and shall also annually equip with meters 5 per cent. of the services which were unmetered on December 31, 1907. More than the required number were set in Boston during the past year, but there is still a deficiency in the total number from previous years.

The number of meters set in these municipalities during the past three years, compared with the number required by law, is as follows:—

	NUMBER OF METERS REQUIRED BY LAW.			NUMBER OF METERS SET.		
	On Old Services.	On New Services.	Total.	On Old Services.	On New Services.	Total.
Boston,	13,314	3,462	16,776	11,068	2,313	13,381
Quincy,	690	1,170	1,860	814	315	1,129
Revere,	414	527	941	379	348	727

The following table gives the statistics relative to the setting of meters and the number of service pipes and meters connected with the distributing pipes in the District on December 31, 1910:—

CITY OR TOWN.	Number of Meters required to be set on Old Services Each Year.	METERS SET ON OLD SERVICES.			New Services installed, 1910. ¹	New Services equipped with Meters, 1910. ¹	Services in Use December 31, 1910.	Meters in use December 31, 1910.	Per Cent. of Services metered December 31, 1910.
		1908.	1909.	1910.					
Boston,	4,438	84	5,503	5,481	1,134	1,134	93,780	18,720	19.96
Somerville,	411	732	621	501	149	227	12,149	5,810	47.82
Malden,	14	43	62	8	161	177	7,440	7,163	96.28
Chelsea,	240	198	756	779	105	105	4,790	3,082	64.34
Everett,	252	338	255	277	62	77	5,380	1,186	22.04
Quincy,	230	358	33	423	493	179	7,307	2,634	36.05
Medford,	179	857	927	1,555	149	149	4,550	4,296	94.42
Melrose,	119	2,432	135	7	79	263	3,583	3,777	100.00
Revere,	138	85	184	110	188	185	3,402	885	26.01
Watertown,	-	-	-	-	69	97	2,042	2,070	100.00
Arlington,	55	108	56	63	83	104	2,050	1,288	62.83
Milton,	-	-	-	-	74	74	1,454	1,454	100.00
Winthrop,	100	213	975	706	167	167	2,487	2,386	95.94
Stoneham,	65	116	225	186	21	21	1,467	635	43.29
Belmont,	-	-	-	-	63	63	909	909	100.00
Lexington,	32	113	70	56	57	57	836	475	56.82
Nahant,	16	30	40	26	20	22	532	227	42.67
Swampscott,	21	264	142	28	82	82	1,478	1,465	99.12
Totals,	6,310	5,971	9,984	10,206	3,156	3,183	155,636	58,462	37.56

¹ The number of new meters installed and the number of new services equipped with meters seldom agree exactly for the reason that service pipes are installed but meters are not set until the buildings are permanently occupied.

This table was first prepared for the annual report in accordance with the original returns received from the various municipalities. Revised returns received have caused some changes to be made, particularly in the figures applicable to the city of Boston.

At the end of the year 37.56 per cent. of all the service pipes in the District were metered, as compared with 28.35 per cent. at the beginning of the year. During the past year meters have been placed on a large number of the services in Medford and Winthrop, and at the end of the year there were 8 municipalities in which 94 to 100 per cent. of the services were metered.

QUALITY OF THE WATER.

The water in the Wachusett and Sudbury reservoirs and Framingham Reservoir No. 3, from which the entire supply of the Metropolitan District was drawn, has been almost entirely free from organisms causing objectionable tastes and odors. The examinations made by the State Board of Health, as well as those made in the laboratory of the Board, have shown that the water delivered in the District has had a lower color and less residue than in any previous year, and that in all respects its quality has compared very favorably with that supplied during previous years.

The growth of *Asterionella*, which gave the water an objectionable taste and odor for several months in 1909, was not present in sufficient quantity to be objectionable. There was a small growth of *Uroglena* in the water of Sudbury Reservoir, lasting about two weeks in April, which reappeared about the 10th of May and remained in decreasing quantity until the first of June. *Chlamydomonas* and *Dinobryon* were present in the Sudbury Reservoir during the latter half of the year, but never in sufficient quantity to cause trouble. Framingham Reservoir No. 3 contained the same organisms as the Sudbury Reservoir, in small numbers.

The weekly, biweekly and monthly collection and examination of samples of water from the several reservoirs, as well as from taps at several points in the Metropolitan District, have been continued as in previous years. There have been made 2,377 microscopical and 961 bacterial examinations.

The water in Framingham Reservoir No. 2 and in the Ashland, Hopkinton and Whitehall reservoirs was free from objectionable organisms throughout the year. The color of the water in these reservoirs varied from .84 to .116 during the early part of the year and from .38 to .48 during the last six months.

A growth of *Chlamydomonas* in Lake Cochituate has given the water in that reservoir a disagreeable odor during practically the entire year. Its average color was .26.

There have been small growths of *Uroglena* in all the distributing reservoirs in the Metropolitan District. The largest numbers were observed in Spot Pond in February and May, in Waban Hill Reservoir about the first of February and during the latter part of May and in Bear Hill Reservoir in May. Although faintly dis-

agreeable odors have been noted in the hot water as drawn from the taps, there has been neither noticeable taste nor odor in the cold water, and no complaints have been received from the water takers. The average color of the water delivered from the low-service taps was .18 and from the high-service taps .12.

The following table gives a comparison of the average results of the examinations of water from a tap in Boston for the years 1902 to 1910, inclusive:—

	1902.	1903.	1904.	1905.	1906.	1907.	1908.	1909.	1910.
<i>State Board of Health Examinations.</i>									
Color (Nessler standard), .	0.26	0.25	0.23 ¹	0.24 ¹	0.24 ¹	0.22 ¹	0.19 ¹	0.18 ¹	0.14 ¹
Total residue,	3.93	3.98	3.93	3.86	3.86	3.83	3.50	3.46	3.05
Loss on ignition,	1.56	1.50	1.59	1.59	1.39	1.40	1.35	1.43	1.24
Free ammonia,	0.0016	0.0013	0.0023	0.0020	0.0018	0.0013	0.0011	0.0011	0.0013
Albuminoid ammonia, {	0.0139	0.0125	0.0139	0.0145	0.0159	0.0129	0.0115	0.0128	0.0118
dissolved,	0.0119	0.0110	0.0121	0.0124	0.0134	0.0109	0.0092	0.0103	0.0102
suspended,	0.0020	0.0015	0.0018	0.0021	0.0025	0.0020	0.0024	0.0025	0.0016
Chlorine,	0.29	0.30	0.34	0.35	0.34	0.33	0.33	0.28	0.28
Nitrogen as nitrates, . .	0.0092	0.0142	0.0110	0.0083	0.0054	0.0068	0.0092	0.0034	0.0030
Nitrogen as nitrites, . .	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000
Oxygen consumed,	0.40	0.39	0.37	0.35	0.36	0.32	0.26	0.25	0.22
Hardness,	1.3	1.5	1.5	1.4	1.3	1.3	1.2	1.3	1.1
<i>Metropolitan Water and Sewerage Board Examinations.</i>									
Color (platinum standard),	.33	.35	.32	.28	.25	.27	.22	.23	.18
Turbidity,	2.3	2.2	2.4	1.9	2.2	2.2	2.4	2.6	2.1
Total organisms,	367	286	303	528	550	427	695	1,959	421
Amorphous matter,	34	36	36	37	42	47	64	97	72
Bacteria,	164	126	176	231	154	176	148	195	213

NOTE.—Chemical analyses are in parts per 100,000, organisms and amorphous matter in standard units per cubic centimeter, and bacteria in number per cubic centimeter. The standard unit has an area of 400 square microns, and by its use the number of diatomaceæ are decreased, and the number of chlorophyceæ and cyanophyceæ are very much increased, as compared with the number of organisms.

¹ Platinum standard.

In Appendix No. 2, tables 26 to 32, are given the results of chemical examinations made by the State Board of Health of the water supplied to the Metropolitan Water District.

SANITARY INSPECTION.

The inspection of the several watersheds on which the water supply is collected, and of the grounds connected with the several distributing reservoirs, for the purpose of preventing pollution of the supply or injury to the property of the Board, has been continued as in former years, with a force varying in number from 3 to 15 men. In connection with the inspection a sanitary census has been taken of the several watersheds, and the results as tabulated are presented in the following tables:—

Wachusett Watershed — Sanitary Census by Districts, 1910.

DISTRICT.	PREMISES.					Area (Square Miles, including Water Surfaces).	POPULATION.		Horses.	Cattle.	Sheep.	Swine.	Poultry.	Dogs.
	Number on which there are Dwellings occupied throughout the year.	Summer cottages.	Number on which there are Stores or Other Buildings but no Dwellings.	Vacant.	Total Number.		Permanent.	Summer.						
French Brook,	49	4	4	1	58	7.30	206	26	42	219	4	13	1,220	18
Muddy Brook,	31	2	2	1	36	3.41	126	9	49	241	—	16	1,067	12
Gates Brook,	127	3	15	8	153	3.93	596	10	96	228	2	51	2,567	35
Malden Brook,	22	3	1	1	27	3.05	121	11	32	138	—	7	1,042	12
Chaffin Brook,	162	1	6	12	181	10.56	733	5	111	306	—	140	5,914	59
Asenubskit Brook,	198	15	28	41	282	12.96	980	382	185	416	11	169	5,620	67
Muschopauge,	64	6	5	13	88	11.88	305	157	101	381	—	96	3,138	35
South Wachusett Brook,	61	12	8	4	85	11.33	228	72	96	434	25	35	1,862	23
Trout Brook,	28	1	2	2	33	7.65	116	3	28	85	—	13	1,248	11
East Wachusett Brook,	146	27	18	18	209	20.88	604	384	240	597	20	99	5,015	43
Stillwater River,	121	3	10	9	143	11.87	586	130	133	536	20	75	4,189	34
Wachusett,	130	218	20	8	376	7.70	571	815	131	429	—	87	2,779	35
French Hill,	28	—	1	1	30	5.67	110	—	20	51	—	1	412	9
Totals,	1,167	295	120	119	1,701	118.19	5,282	2,004	1,264	4,061	82	802	36,073	393

Sudbury and Cochrane Watersheds — Sanitary Census by Districts, 1910.

DISTRICT.	PREMISES.				POPULATION.		Area (Square Miles, including Water Surfaces).	Population per Square Mile in Dwellings not connected with Sewer.	WATER SUPPLY.				Horses.	Cattle.	Sheep.	Swine.	Poultry.	Dogs.
	Number on which there are Dwellings.	Number on which there are Stores or Other Buildings but no Dwellings.	Vacant.	Total Number.	Connected with Sewer.	Total.			In Dwellings not connected with Sewer.	Premises supplied by Public Water Supply.	Premises supplied by Private Wells, Cisterns, etc.	Premises on which there is no Water Supply.						
Sudbury Watershed.	Farm Pond,	238	31	5	274	254	1,568	0.54	337.0	263	—	11	84	2	—	—	749	49
	Framingham Reservoir No. 3, . . .	82	2	3	87	—	363	5.35	67.9	—	54	3	95	309	36	48	3,005	41
	Stony Brook,	250	21	24	295	—	1,302	13.29	98.0	—	271	24	275	898	16	205	6,476	127
	Angle Brook,	1,808	116	52	1,976	1,522	11,016	9.16	246.2	1,814	96	66	509	306	1	590	12,159	509
	Framingham Reservoirs Nos. 1 and 2, and Cold Spring Brook, . .	280	6	22	308	—	1,263	11.72	107.8	44	288	26	167	458	35	191	8,601	127
	Eastern Sudbury,	190	18	12	220	—	884	3.11	284.2	44	208	12	58	72	4	22	2,832	72
	Indian Brook,	356	26	32	414	—	1,402	7.17	195.5	140	223	51	99	170	—	99	7,245	100
	Western Sudbury,	160	16	8	184	—	641	7.85	81.7	—	176	8	92	297	27	77	7,062	71
	Whitehall Reservoir,	90	8	15	113	—	321	7.61	42.2	40	55	18	55	142	1	41	4,591	32
	Cedar Swamp,	702	49	47	798	510	3,351	9.40	121.6	687	50	61	235	487	2	243	9,619	158
	Totals,	4,156	293	220	4,669	2,286	22,111	75.20	129.7	2,988	1,401	280	1,069	3,201	122	1,516	62,339	1,286
	Cochituate Watershed.	Snake Brook, ¹	307	18	5	330 ²	—	1,609	4.73	340.2	296	22	12	95	139	—	274	5,631	97
Pagan Brook,		877	71	11	959 ²	656	4,455	2.24	626.8	926	12	21	268	90	—	17	4,883	296
Course Brook,		81	2	4	87	2	610	3.61	97.0	43	38	6	92	349	—	116	3,848	67
Beaver Dam Brook,		1,076	77	28	1,181	866	7,844	8.15	185.8	1,014	120	47	328	261	—	115	9,989	375
Totals,		2,341	168	48	2,557	1,524	14,518	18.73	260.4	2,279	192	86	783	839	—	522	24,351	705
Totals for both watersheds, . . .		6,497	461	268	7,226	3,810	36,629	93.93	155.8	5,267	1,593	366	2,452	4,040	122	2,038	86,690	2,051

* Not including 98 summer cottages and camps on the shores of Lake Cochituate, with a population of 302 on August 1, 1910.

† Includes Duxley Pond.

A comparison of these results with those of the Census of 1905 is shown by the following table:—

	WACHUSETT WATERSHED.		SUDBURY WATERSHED.		COCHITUATE WATERSHED.	
	1905.	1910.	1905.	1910.	1905.	1910.
Premises occupied,	1,658	1,582	4,607	4,449	2,873	2,509
Premises vacant,	102	119	303	220	74	48
Premises connected with sewer,	—	—	1,898	2,286	1,427	1,524
Permanent population,	5,772	5,282	21,131	22,111	15,508	14,518
Permanent population per square mile in dwell- ings not connected with sewers,	49	44.7	140.6	129.7	328.7	260.4
Unsatisfactory cases,	195	61	228	65	133	39

On the Wachusett watershed there has been a reduction of 9 per cent. in the population, and the number of unsatisfactory cases has been reduced from 195 to 61. Since 1905 several buildings on property purchased by the Board for the protection of the water supply, including the Dorr and Warfield mills and tenement houses connected therewith, have been torn down. All the large mills in Holden are now either idle or operating with a reduced number of employés. The decrease in population due to these conditions has been partially offset by the construction of 103 new houses, largely in the towns of West Boylston and Holden, which lie nearest Worcester, and to which better transportation facilities have recently been furnished.

On the Sudbury watershed there has been a reduction in the number of persons residing in houses not connected with sewers which discharge outside the watershed, and the unsatisfactory cases have been reduced from 228 to 65.

The drainage from the Dug Pond watershed, on which there was a resident population of 2,547, was diverted from the Cochituate watershed into Charles River in 1909 and although the remainder of the watershed gained 1,557 in population during the five years, there has been a decrease of 6 per cent. in the resident population on the Cochituate watershed, and the number of unsatisfactory premises has been reduced from 133 to 39.

Under the heading "unsatisfactory" are included all cases where it is possible that under the most unfavorable conditions drainage from privies or sinks may reach a water course, all suspected cases

and all cases of manufacturing wastes entering feeders, even though there may have been some attempt at previous purification.

On the Sudbury watershed 14 old and 18 new premises were, during the past year, connected with the public sewers which convey the drainage outside the watershed. Seven of these are in Marlborough, 10 in Westborough and 15 in Framingham. On the Cochituate watershed 13 old and 49 new premises were connected. Fifty of these are in Framingham and 12 in Natick. In the city and towns on the Sudbury and Cochituate watersheds which have systems of sewerage conveying the sewage outside the watershed, there were, on December 31, 1910, 3,810 premises connected with the sewers and 150 premises not yet connected on streets where there are existing sewers, as follows:—

	Premises connected with Sewers.	Premises not connected with Sewers.
Marlborough,	1,522	83
Westborough,	510	25
Framingham,	1,116	9
Natick,	656	33
Sherborn,	6	—
	3,810	150

In Marlborough the regrading of some of the streets has changed the watershed line so that several houses which have been included in previous years are now outside the watershed. This has reduced the number of connections as given in the tables of former years.

Two watchmen were employed to patrol the grounds at Lake Cochituate, one from April 18 to October 1, with special reference to the protection of the supply during the bathing and camping season, and the other from July 16 to December 10, during the camping season and while the Italian laborers employed in constructing a drainage system were engaged in the vicinity of the lake.

The Boston & Worcester Street Railway Company employed a large gang of men for several months in grading the south side of the highway between Framingham Centre and the Southborough line. Measures were taken to prevent the pollution of the watershed on account of this work.

Two boys were summoned into court for bathing in Spot Pond on July 10. They were placed on probation.

On February 24 a resident of West Boylston was arrested for hunting on the marginal lands of the Wachusett Reservoir, and a fine of \$5 was imposed by the court.

The presence of a large number of visitors on the reservoir grounds at Chestnut Hill and Spot Pond during the summer season has made necessary the employment at times of men in patrolling the lands of the Board for the purpose of preventing the pollution of the supply and protecting the property. The extension of a car line from Boston through the Middlesex Fells to Stoneham has caused a very great increase in the number of people visiting the grounds around Spot Pond and the Fells Reservoir.

There were 3 cases of typhoid fever reported upon the Wachusett watershed, 1 of which was in Holden, 1 in Princeton and 1 in Boylston, and there were 2 cases of dysentery in Holden.

On the Sudbury and Cochituate watersheds there were 24 cases of typhoid fever reported from Marlborough, 4 from Westborough, 1 from Ashland, 83 from Wayland, 12 from Framingham and 6 from Natick, a total of 130 cases. Investigations made by our inspectors appear to indicate that the large number of cases which occurred in the village of Cochituate, in Wayland, during July, August and September were due to the use of milk from bottles which had not been properly sterilized.

The 24 cases in Marlborough were distributed throughout the year as follows:—

January,	1	September,	6
February,	2	October,	1
March,	1	November,	2
May,	2		—
August,	9		24

The patients in 4 of the cases reported in September had been camping at Boone's Pond, in Hudson, and probably contracted the disease while there. Twenty-one of the premises from which cases were reported are connected with the public sewers. In all cases the premises were visited and precautions taken to prevent the spread of the disease or the pollution of the water supply.

A summary of the work of sanitary inspection for the year 1910 is given in the following tables:—

Summary of Sanitary Inspections on the Wachusett Watershed in 1910.

DISTRICT.	Number of Premises in- spected. ¹	CLASSIFICATION OF CASES INSPECTED.											CONDITION AT END OF YEAR.		WATER SUPPLY.					
		Cesspools dug before 1910.	Cesspools dug during 1910.	Direct Privy Drain- age.	Indirect Privy Drain- age.	Direct Sink Drainage.	INDIRECT SINK DRAINAGE.		BARN DRAINAGE.		Manufacturing Wastes.	Premises Vacant.	No Drainage.	Drainage carried to Filter beds.	Satisfactory.	Unsatisfactory.	Premises having Pub- lic Water Supply.	Premises supplied by Private Wells, Cist- erns, etc.	Premises on which no Water is used.	
							Satisfactory.	Unsatisfactory.	Satisfactory.	Unsatisfactory.										
French Brook, . . .	58	26	1	-	-	-	27	2	27	1	-	1	1	2	-	55	3	8	48	2
Muddy Brook, . . .	36	12	1	-	-	-	21	-	22	-	-	-	1	-	1	36	-	-	36	-
Gates Brook, . . .	153	98	5	-	1	-	41	-	50	-	-	-	8	2	-	152	1	-	143	10
Malden Brook, . . .	27	13	1	-	-	-	12	-	22	-	-	-	1	1	-	27	-	-	26	1
Chaffin Brook, . . .	181	85	4	-	1	-	72	8	87	-	-	-	12	3	-	173	8	66	104	11
Asnebumskit Brook, .	272 ²	134	3	2	3	8	68	7	89	-	2	41	8	2	-	255	17	173	82	17
Muschopauge, . . .	88	22	-	-	1	1	51	2	42	1	-	13	1	-	-	84	4	5	78	5
South Wachusett Brook,	85	32	-	1	1	1	43	3	50	1	-	4	4	-	-	80	5	-	81	4
Trout Brook, . . .	33	4	-	-	-	-	25	1	26	-	1	-	-	-	-	31	2	-	32	1
East Wachusett Brook, .	209	80	-	2	-	4	103	5	106	3	-	18	3	1	-	196	13	-	199	10
Stillwater River, . . .	143	54	-	-	-	-	76	2	75	2	-	9	2	1	-	140	3	-	137	6
Wachusett, . . .	166 ³	62	3	-	-	1	87	3	53	2	-	8	-	6	-	161	5	-	148	18
French Hill, . . .	30	19	-	-	-	-	9	-	12	-	-	1	1	1	-	30	-	-	29	1
Totals, . . .	1,481	641	18	5	7	15	635	33	666	10	3	119	34	86	-	1,420	61	252	1,143	86

¹ On some premises there are two or more cases.² Not including 10 summer cottages at Asnebumskit Pond.
³ Not including 210 summer cottages near Wachusett Lakes.

Summary of Sanitary Inspections on the Sudbury and Cochituate Watersheds in 1910.

DISTRICT.	Number of Premises in- spected. ¹	CLASSIFICATION OF CASES INSPECTED.												CONDITION AT END OF YEAR.			
		Sewer Connections.	Cesspools dug before 1910.	Cesspools dug during 1910.	Direct Privy Drain- age.	Indirect Privy Drain- age.	Direct Sink Drainage.	INDIRECT SINK DRAINAGE.		BARN DRAINAGE.		Manufacturing Wastes.	Premises Vacant.	No Drainage.	Drainage carried to Filter-beds.	Satisfactory.	Unsatisfactory.
								Satisfactory.	Unsatisfactory.	Satisfactory.	Unsatisfactory.						
<i>Sudbury Watershed.</i>																	
Farm Pond,	274	254	9	2	1	1	1	34	3	17	5	7	1	273	1		
Frammingham Reservoir No. 3,	87	—	40	3	—	—	—	39	3	43	3	2	—	84	3		
Stony Brook,	295	—	209	10	—	—	—	114	3	114	24	12	1	289	6		
Angle Brook,	1,976	1,522	290	7	1	2	104	3	227	1	52	17	1,782	1,973	3		
Frammingham Reservoirs Nos. 1 and 2,	308	—	174	7	—	—	95	3	97	—	22	6	—	305	3		
and Cold Spring Brook,	220	—	161	2	1	1	31	1	36	—	12	11	—	218	2		
Eastern Sudbury,	414	—	195	4	4	4	147	13	73	2	32	14	—	396	18		
Indian Brook,	184	—	67	3	1	—	67	10	67	—	8	9	—	173	11		
Western Sudbury,	113	—	23	4	1	—	61	2	37	—	15	5	—	111	2		
Whitehall Reservoir,	798	510	170	3	1	—	61	16	133	—	47	14	—	782	16		
Cedar Swamp,																	
<i>Cochituate Watershed.</i>																	
Snake Brook,	330	—	231	8	3	1	60	13	69	—	5	9	—	316	14		
Pegan Brook,	959	656	225	6	—	3	40	—	93	—	1	10	923	959	1		
Course Brook,	87	2	58	2	—	—	19	1	43	—	4	2	—	86	1		
Beaver Dam Brook,	1,181	866	299	10	1	2	44	19	165	3	28	14	—	1,157	24		
Totals,	7,226	3,810	2,077	71	9	13	811	88	1,214	8	268	132	2,706	7,122	104		

¹ On some premises there are two or more cases.

SWAMP DITCHES AND BROOKS.

The drainage ditches and swamps on the several watersheds, aggregating 36.36 miles in length, have been cleaned, and the weeds and brush mowed and burned for a width of from 10 to 20 feet on either side of the ditches. The work of replacing decayed wooden bulkheads on the settling basins at the outlets of ditches entering the open channel of the Wachusett Aqueduct was begun in 1909, and has been completed during the past year by the construction of eight concrete bulkheads 8 inches in thickness, fitted with stop-planks to control the elevation of the water. The cost of the work done during the past year was \$345.15. A dry rubble retaining wall on the west side of the highway leading from Marlborough to Westborough, at the crossing of the ditch leading from Brigham Pond, collapsed on March 18. It was rebuilt with stone laid in cement, at a cost of \$457.19, the work being finished on April 8. The slopes of the drainage ditches in swamps Nos. 54, 55 and 56, in Holden and Princeton, have been repaired for a distance of 1.46 miles, at a cost of \$104.03.

On the Sudbury watershed forty new farm bridges have been built over the drainage ditches, at points where the old bridges were decayed, and the ditches were repaired at several points by replacing the board bottom or repaving the slopes for an aggregate distance of 952 feet on the several ditches. The intercepting ditch along the east side of Pegan Meadow, at Lake Cochituate, was cleaned and the slopes mowed.

Observations of the colors of the waters from swamps have been made monthly and the results tabulated as follows:—

SWAMP.	Area of Watershed (Acres).	Area of Swamp (Acres).	Length of Ditches (Feet).	COLORS OF WATERS (PLATINUM STANDARD).					
				BEFORE DRAINING.		AFTER DRAINING.			
				Averages for Years 1894, 1895, 1899.	Averages for Years 1900, 1901, 1902.	1907.	1908.	1909.	1910.
Crane, . .	1,856	460	45,250	1.95	—	.77	.72	.64	.65
No. 54, . .	750	72	8,930	—	.90	.53	.41	.33	.36
No. 55, . .	1,625	220	27,661	—	1.27	.80 ¹	.44	.36	.38
No. 76, . .	225	26	6,173	—	.44	.27	.24	.20	.21

¹ Nearly one-half of the ditches in Swamp No. 55 were not built until 1907.

PROTECTION OF SUPPLY.

In addition to the work of sanitary inspection and the care of the swamp ditches, the work of protecting the supply has included the maintenance and operation of filter-beds used to purify the surface water from thickly populated districts before it is admitted to the storage reservoirs. The Marlborough Brook filter-beds, with an area of 14 acres, filter the water from about 1.8 square miles of the thickly settled portion of the city of Marlborough before it is admitted to the Sudbury Reservoir. The settling basin in which the brook water is first received was cleaned in May and June. About 1,600 cubic yards of street washings and silt were removed and disposed of in grading the adjacent grounds, at a cost of about 28 cents per yard. The artificial filter-beds were cleaned twice during the year, once in June and again in September. The entire flow of the brook was filtered, with the exception of a small amount which overflowed from one of the beds into the reservoir on February 28 and March 1. Diluted sewage from the overflow of the Marlborough main sewer ran into the filter-bed on Farm Road on 5 days in January, 4 days in February, 11 days in March and 1 day in December, and there was a flow of ground water into the bed at times during the first four months and the last month of the year.

Surface drainage from an area of about one square mile in the thickly settled portion of Natick is collected in a basin and then pumped to filter-beds before entering Lake Cochituate. The pumps were operated on 155 days during the year, which is a less number than in any year since the beds were constructed. The total quantity pumped during the year was 210,806,000 gallons, equivalent to a daily average of 577,550 gallons. Of the total, 165,037,000 gallons were from Pegan Brook and 45,769,000 gallons from the intercepting ditch which collects water from brooks formerly draining into Pegan Brook Meadow. All of the water from Pegan Brook was filtered, but small quantities from the intercepting ditch were discharged into the lake on 5 days in January, 4 days in February and 5 days in March. The total quantity of coal consumed was 140,658 pounds, and 1,499 gallons of water were pumped per pound of coal. The cost of operating the station, cleaning the filter-beds and caring

for the grounds was \$2,691.58, making the cost per million gallons treated \$12.77.

The Sterling filter-beds have been in continuous operation throughout the year. All of the water coming from the brook which passes through the centre of the town of Sterling enters the filters, and has been efficiently cared for.

The Worcester County Training School filter-beds have been in operation continuously throughout the year, caring for all of the sewage of this institution.

The Gates Terrace filter-beds at Sterling Junction were in commission continuously from April 12 to November 12, inclusive.

FORESTRY.

In connection with the several reservoirs and aqueducts the Board has under its care and control about 10,000 acres of land a large part of which is covered with trees. Around the Wachusett Reservoir 1,341 acres of land have been planted with white pines during the past eight years. A considerable number of white pines have been planted around the Sudbury Reservoir. There are still several hundred acres on which it is proposed to plant pines, but the greater part of the forestal work now consists in the care of the trees which have been planted, the improvement thinning of forested areas and the care and improvement of forest roads. No additional area was planted on the Wachusett watershed during the past year with white pines as there was no suitable stock available, but the margin of the reservoir was replanted, for a distance of 13.6 miles, with *arbor vitæ*, spaced 3 feet apart in rows 2 feet apart. This work was necessary because a large proportion of the trees first planted had died. Thirty-six thousand one hundred trees were used in doing this work. Continuing work begun in 1909, 1,281 maples and 230 locusts have been transplanted from fields to the sides of 8.8 miles of highway in Clinton, Boylston, West Boylston and Sterling. Eighty-four white pine trees, averaging 6 feet in height, have been set out on a small grass plot opposite the Boston & Maine Station at Oakdale, also 7 white oaks. Eighteen sugar maples and 10 white oaks have been planted on the grounds at the Wachusett Dam. An area of 1.4 acres on Waushacum Street, in Oakdale, has been cleared and pre-

pared for use as a nursery for the propagation of trees, and it now contains about 30,000 white pine seedlings. The necessary care has been given to the Lamson and Flagg nurseries, and they now contain 18,200 two-year old white pine transplant seedlings and 42,800 arbor vitæ seedlings from 12 inches to 24 inches in height. The work of cutting out trees and brush which interfered with the growth of the young pines, and of making improvement thinning in timber stands varying from twenty to fifty years in age, has been continued.

Around the Wachusett Reservoir an improvement thinning on 112 acres of white pines was made at a cost of \$495.69, less \$114 received for 58 cords of wood; and 53 acres of old timber land was improved without any expense, as the value of the timber, cord wood, fence posts and railroad ties obtained was fully equal to the cost of making the improvement.

The brush and weeds on all forest roads, along all highway roadsides and on the 40-foot marginal fire guard at the Wachusett Reservoir have been cut and burned.

The lands about the Sudbury Reservoir have been improved by planting 2,500 arbor vitæ seedlings along the shore, on land formerly owned by S. A. and H. S. Howe on Parmenter Street, and on land formerly of W. A. Fay near the Framingham-Marlborough Road.

At Lake Cochituate 1,630 white pines have been planted on land made in 1909 by filling two shallow coves, and 50 white pines have been planted on the grounds at the effluent gate-house.

Three hundred pine trees were set out on the Sudbury Aqueduct land near Wellesley Avenue, in Wellesley, 100 alongside the Cochituate Aqueduct on land in Natick purchased of Harry Felch, and about 500 along the line of the Weston Aqueduct.

On the grounds about the Weston Reservoir 880 trees of different kinds have been set out, and at Spot Pond 100 trees and 2 shrubbery beds have been planted.

The work of protecting trees and shrubbery from the ravages of gypsy and brown-tail moths, pine-tree weevils, elm-leaf beetles and other destructive insects has caused the expenditure of \$6,010.21, distributed as follows:—

Spot Pond,	\$2,645 35
Mystic Lake, pumping station and reservoir,	144 85
Chestnut Hill Reservoir,	648 89
Weston Reservoir and Aqueduct,	1,246 75
Sudbury and Cochituate aqueducts,	300 50
Lake Cochituate,	109 25
Sudbury Reservoir,	128 67
Framingham Reservoir No. 3,	20 00
Wachusett Reservoir and Aqueduct, gypsy and brown-tail moths,	185 31
Wachusett Reservoir, pine-tree weevil,	580 64
	<hr/>
	\$6,010 21

This sum is about \$2,000 less than the amount expended for the same purposes in 1909.

The method of destroying the insects has been the same as that followed in previous years. During the winter months the egg clusters of the gypsy moth were treated with a mixture of fuel oil and creosote, and the webs of the brown-tail moth were cut off and burned. Wherever the gypsy and brown-tail caterpillars or the elm-leaf beetles were present in large numbers during the summer the trees were sprayed with a mixture of arsenate of lead and water.

The large areas of young pine trees at the Wachusett Reservoir were inspected twice during the season, and all shoots found infested with the weevil were cut off and burned.

At Spot Pond the trees on about 14 acres of land were sprayed between May 26 and July 20, using 650 pounds of arsenate of lead, and 600 pounds of tanglefoot were used in banding the trees. At Chestnut Hill Reservoir 600 pounds of tanglefoot and 890 of arsenate of lead were used. At both Spot Pond and Chestnut Hill the elm-leaf beetle was very destructive, and constant watching and great thoroughness in spraying the trees were required to accomplish effective results. The elm trees were sprayed three times during the season.

At the Weston Reservoir 725 pounds of tanglefoot and 375 pounds of arsenate of lead were used, and about 14 acres of trees were sprayed. At this reservoir the cost of the work was largely increased by the fact that nothing whatever was done to suppress the moths by some of the adjacent property owners. The elm-leaf beetle was more prevalent than in previous years.

Along the Sudbury and Cochituate aqueduct lines the moths were found and destroyed in considerable numbers as far west as Wellesley and Natick.

At the Sudbury Reservoir 1,535 nests of the brown-tail moth and 65 egg clusters of the gypsy moth were destroyed, and a large number of pine tree shoots infested with the weevil were cut off and burned.

A few egg clusters of the gypsy moth have been found in the vicinity of the Wachusett Reservoir. The pine-tree weevil infested the young pines as in previous years but in smaller numbers. During July the whole area of 1,341 acres planted with young pines was inspected, and a second inspection was made in August. The proportion of trees infected varied from 1 in 3 on one or two small lots to 1 in 40 over a large proportion of the area.

In consequence of the extreme drought of the past year the number of forest fires has been unusually large, notwithstanding the fact that a fire-patrol service was maintained on Sundays and holidays at the Wachusett Reservoir and Spot Pond during the spring and fall. Twenty-four fires occurred on the property of the Board, causing a loss of about \$2,500. The more important of these were two at the Wachusett Reservoir, which destroyed about 16,000 young pine trees, two in Crane Swamp, which burned over about 90 acres of peat swamp covered with trees, and one near the Hopkinton Reservoir on the Sudbury watershed, which destroyed a good growth of chestnut and oak on about 30 acres.

DISTRIBUTING RESERVOIRS.

Weston Reservoir.

The reservoir, with its connected structures and grounds, has received the usual care and is in good order.

Chestnut Hill Reservoir.

The reservoir, gate-chambers and grounds are in good condition. The exterior woodwork of the old effluent gate-house has been given two coats of paint, and the iron floor of effluent gate-house No. 2 has been scraped and painted.

Waban Hill Reservoir.

The reservoir, gate-house and grounds are in good order.

Forbes Hill Reservoir and Standpipe.

The standpipe has been in use the entire year, and the reservoir has been kept full of water for use in case of emergency. The iron-work in the standpipe tower and the woodwork in the reservoir gate-chamber have been painted. The upper floor of the tower should be resurfaced.

Mystic Reservoir.

The roadway around the reservoir has been repaired, and the exterior woodwork and roof of the gate-house have been given two coats of paint. The reservoir has been in continuous use, except from November 10 to 21, when it was shut off on account of a drowning accident.

Mystic Lake and Pumping Station.

The Metropolitan Park Commission has been allowed to take about 1,500 cubic yards of gravel from a gravel pit on the west shore of the lake for use in resurfacing the Mystic Valley Parkway. A piece of land lying between old and new Mystic Streets, and containing 32,450 square feet, has been sold, as it had no value in connection with the water supply. The exterior woodwork of the old Mystic pumping station and the interior of the stable on the pumping station grounds have been painted.

Arlington Standpipe.

The standpipe has been in use the entire year. No repairs have been made during the year, but the standpipe should be repainted during the coming season.

Spot Pond.

The woodwork of the gate-houses has been painted and the interior ironwork given a coat of black varnish. For the convenience of the large number of visitors at the pond, and as an inducement to keep them away from the water, paths have been constructed on the property of the Board as follows: through what is known as the Deer Hill Lot, between Main Street and Dark Hollow Pond, for a distance of 2,850 feet; on the Hammer Neck Lot for a distance of 2,520 feet; and on the east shore of the pond from Woodland Road, passing by the rear of the pumping station, to the boat-house, a distance of about 1,500 feet. It is proposed to continue the construction of these paths

during the coming season. The question of the efficient protection of the water stored in this reservoir from pollution is becoming a serious one, on account of the large number of people who now use as a picnic ground the land draining into the pond, and it seems probable that a system of drains will soon be required to divert all surface water from the watershed from the pond.

PIPE YARDS.

The buildings at the Chestnut Hill and Glenwood pipe yards are in good condition, those at the Glenwood yard having received two coats of paint in the spring and those at the Chestnut Hill yard in the fall. The interior of the stable at Chestnut Hill was given a coat of hard oil finish.

PIPE LINES.

The length of pipe lines owned and operated by the Metropolitan Water and Sewerage Board was increased by 4.49 miles during the year, making a total on December 31, 1910, of 97.02 miles. The length of mains 4 inches in diameter and larger, connected with the works but owned and operated by the several cities and towns supplied with water, is 1,633.37 miles.

A number of changes in the Metropolitan pipe lines and in the connections between the Metropolitan mains and the pipes of the local distribution systems have been made during the year. The most important work done has been the relaying of 827 feet of 48-inch main on Boylston Street, in Cambridge, between the parkway at Charles River and Eliot Street. The relaying of this pipe, which had been in the ground but fourteen years, was made necessary by its having been injured by electrolysis, so as to be unsafe for further use. The pipes originally laid were 1.4 inches in thickness. The new pipes laid were 1.7 inches in thickness, and all of the joints, with the exception of those on a curve, were made of wood in place of lead, for the purpose of insulating the pipes and preventing injury in the future. This work was commenced on October 16 and completed on November 30, at a cost of \$12,221.40.

The construction of Crafts Road, crossing Reservoir Lane in Brookline, has made necessary the lowering of the 48-inch main in Reservoir Lane for a distance of about 275 feet and to a maximum

vertical distance of 6 feet. The main, was lowered on November 8 without disconnecting the pipes, by the use of screws from which the main was suspended while the deeper trench was being excavated. In order to lower the pipes to the new grade it was necessary to cut into the top of the old Cochituate Aqueduct to a depth of about 1.6 feet. It is not probable that this portion of the aqueduct will ever be used, but to provide for possible use the brickwork was replaced. The cost of the portion of the work of lowering this main done by the Board was \$878.08, which is to be paid for by the town of Brookline.

The 20-inch main which is laid under the Mystic River at High Street, between Medford and Arlington, has been lowered so as to permit of the excavation of a deeper river channel by the Metropolitan Park Commission. The main was lowered for a length of 130 feet, at a cost of \$820.70. As the towns of Arlington and Lexington were entirely dependent upon this main for their water supply, a connection was made between the local distribution pipes in Arlington and Somerville by laying 591 feet of 8-inch pipe, of which 231 feet were furnished by the city of Somerville. By means of this connection a partial supply can be furnished in cases of emergency. The cost of making this connection was \$643.37.

The construction by the city of Boston of a large culvert at a new location, for use in carrying the waters of Stony Brook under Morton Street, near the Austin Farm, in West Roxbury, has made necessary the relocation of the Metropolitan 36-inch main. In order to avoid interference with the water-way through the culvert, the pipe line was reduced to 30 inches in diameter, and raised so that the top of the pipe is now within 2 feet of the surface of the street for a short distance directly over the culvert.

The construction of the subway in Cambridge by the Boston Elevated Railway Company has necessitated the relocation of 48-inch Metropolitan mains at Central and Harvard squares.

The changes at Central Square were described in the report for 1909, but the work was not completed until June 9 of the past year.

The construction of a subway station at Harvard Square has necessitated the relocation of the 48-inch main from a point 100 feet south of the corner of Boylston and Brattle streets to a point in Massachusetts Avenue 117 feet north of Church Street, a distance

of about 650 feet. The relocated pipe line is supported on the masonry structure of the subway for a distance of 400 feet, and at each of the points where the pipes leave the masonry support ball and socket joints were used as a safeguard in case of settlement of the pipes in the earth. At Brattle Street, on account of the shallow depth of cover over the subway roof, the 48-inch main was subdivided into three 24-inch mains, which are laid in special troughs constructed in the subway roof and covered with slabs of reinforced concrete, which protect the pipes from the heavy loads of street traffic. The 24-inch lines are each about 120 feet long, with a valve at either end. The concrete piers which support the 48-inch pipe over the subway are 9 feet long, 5 feet wide and from 6 inches to 2.7 feet high, depending upon the depth of the subway roof below the pipes. In order to maintain the flow of water while the subway construction was in progress a temporary 36-inch main was laid for a distance of 298 feet, and used from June 2 until October 16. The cost of all of these changes, both at Central and Harvard squares, was paid by the Boston Elevated Railway Company, and the employés of the Railway Company performed a large part of the work. The necessary pipes, special castings and valves were obtained under the supervision of this department, and all of the work not done by the department employés was very carefully inspected. The cost of the work done and materials furnished by the Board in connection with the changes at both Central and Harvard squares was \$16,693.75.

The two 24-inch mains crossing Chelsea Creek, used in supplying the East Boston District, have been covered with gravel, and the embankments riprapped where they were exposed at low water on the Chelsea shore.

A wooden insulation joint was substituted in December for a rubber joint in the 48-inch main on North Harvard Street, in Brighton, near the Charles River.

Forty-five leaks have been repaired on pipe lines maintained by the Board, at a cost of \$1,643.77. No serious breaks occurred in the mains during the year, but three cracked pipes were discovered, while pipe lines laid by contractors were being tested, before the mains had been placed in service. The cost of repairing these was \$165.77.

Nine leaks occurred at joints in the lines of 36-inch pipe crossing

under the Charles and Mystic rivers. In repairing these it was necessary to use a dredging machine and employ a diver. The cost of the repairs was \$955.27. The reduction in the leakage by repairing the submerged pipe lines was 270,000 gallons per day.

Twenty-six leaks were due to defective lead joints, of which four occurred under steam railroad tracks, and five were evidently caused by the settlement of the pipes, due to excavations made for other public work.

The steelwork of the bridge which supports the 48-inch main over the Fitchburg Division of the Boston & Maine Railroad at Massachusetts Avenue, in Cambridge, has been cleaned and painted with two coats of red lead and one coat of Smith's Durable Compound. The sheet lead with which the bottom of the bridge girder was covered in 1907, as a protection against the gases discharged from the locomotives, has been replaced with lead $\frac{5}{64}$ of an inch in thickness. A piece of asbestos mill board $\frac{1}{2}$ inch thick was also secured to the bottom of the girder over each track, as a protection for the sheet lead. A portion of the wooden roof covering the bridge was renewed with spruce lumber and the roof then covered with two-ply paroid roofing paper. The cost of this work was \$537.08.

The pipe bridge over the Mystic River in Medford has been thoroughly cleaned and painted; also three bridges carrying pipes over the Pines River in Saugus.

METERING OF WATER TO MUNICIPALITIES.

There were .62 Venturi meters, in sizes varying from 6 inches to 60 inches, connected with the Metropolitan water mains on December 31, 1910, of which 49 were in use in measuring the water supplied to the several municipalities in the Metropolitan District. There were also 5 Hersey disc meters, 1 Hersey torrent, 1 Hersey detector, 1 Crown and 3 Union rotary meters, which were used to measure the water supplied in districts where the flow was too small to be conveniently measured with a Venturi meter. All of these meters have been read and inspected twice each week, and all necessary repairs made by a regular force of two men with an occasional assistant. Reports have been made monthly to the several municipalities supplied with water, giving the quantities used, and special re-

ports have been made from time to time of the increased use due to leakage or other causes.

Two cases in which the Venturi meters have detected large leaks which did not come to the surface of the ground and were not discovered by the local authorities are worthy of mention. In the city of Medford, in August, the meter indicated an increase of 1,000,000 gallons per day, which was, upon investigation, found to be due to a leak in a cement-lined pipe from which the water was escaping into the Mystic River. In another case a 3-inch main in Brighton was found to be broken, causing a leak, the water escaping into a sewer. The amount of leakage in this case was also about 1,000,000 gallons per day.

PRESSURE REGULATORS AND RECORDING GAGES.

There are eight automatic valves connected with the distribution system. Seven of these have been in constant use during the year to regulate the pressure in the mains in Nahant, Swampscott, Winthrop, Revere, Chelsea, East Boston high service and Lexington, and are in good condition.

The recording pressure gages connected with the distribution system have been in constant use and the average maximum and minimum elevations of the water, due to the pressure at nineteen points in different parts of the District, are given in Appendix No. 2, Table No. 42. The gage in Winthrop has been moved from the Water Works office to the Town Hall on Herman Street.

ELECTROLYSIS.

No complete electrical survey of the Metropolitan water mains was made during the past year, but special measurements have been made from time to time, and a careful examination was made of the pipes removed from Boylston Street, in Cambridge as described on page 118. The iron of these pipes, which was originally 1.4 inches in thickness, was found to be so badly decomposed that over considerable areas the material could be easily cut with a knife to a depth of from $\frac{1}{2}$ to $\frac{3}{4}$ of an inch. In seven lengths of pipe there were pittings one inch in depth. Along the bottom of one pipe there was a continuous pitting in the form of a groove about 3 inches wide, $\frac{5}{8}$ of an inch deep and $10\frac{1}{2}$ feet long, and in one pipe four holes were made entirely through the iron while cleaning out the pittings.

Joints of wood, in place of the ordinary lead joints, have been set on all new pipe lines laid during the year, at intervals of about 500 feet, for the purpose of preventing currents of electricity from following the mains.

CLINTON SEWERAGE.

Pumping Station.

The Clinton sewage-disposal works were in daily operation throughout the year. The quantity of sewage pumped to the filter-beds was 829,000 gallons per day, a decrease of 25,000 gallons per day from the preceding year.

Following are statistics relating to the operation of the pumping station: —

Daily average quantity of sewage pumped (gallons), . . .	829,000
Daily average quantity of coal consumed (pounds), . . .	1,509
Gallons pumped per pound of coal,	549
Number of days pumping,	365

Cost of pumping: —

Labor,	\$1,946 04
Fuel,	1,217 32
Repairs and supplies,	382 56
<hr/>	
Total for station,	\$3,545 92

Cost per million gallons pumped,	\$11.721
Cost per million gallons raised 1 foot high,	0.239

There has been installed in the pump well a 2-inch hydraulic agitator for use in stirring up the sediment from the sewage, which collects around the foot valve of the pump. The pump plungers have been refitted, and a complete set of 72 new rubber valves placed in the pump. The woodwork of both the exterior and interior of the pumping station has been painted.

Filter-beds.

The filter-beds were used in rotation throughout the year, except as interrupted by the work of placing carriers on the beds and the building of sludge beds. Each bed has received an average of 61,100

gallons of sewage in thirty minutes about once in two days. All of the beds were used during the winter season.

The sludge collected in the settling basins, amounting to 688 cubic yards, has all been used on grass lands belonging to the Board at the pumping station and the Wachusett Dam and on the North Dike.

The results of the mechanical analyses of the sewage and effluent are given in the following table:—

[Parts per 100,000]

	1906.	1907.	1908.	1909.	Average of Four Years, 1906-09.	1910.		Whole Year, 1910.
						January to June.	July to December.	
Albuminoid ammonia, sewage, .	.8558	.8442	.5735	.7425	.754	.6633	.7467	.7050
Albuminoid ammonia, effluent, .	.0955	.0744	.0554	.0819	.0768	.0745	.0628	.0686
Per cent. removed, . . .	89	91	90	89	89.7	89	92	90.3
Oxygen consumed, sewage, . .	9.84	7.87	3.43	7.04	7.045	6.10	7.2150	6.658
Oxygen consumed, effluent, . .	1.34	1.07	0.765	1.165	1.085	1.098	0.6742	.8863
Per cent. removed, . . .	86	87	78	83	83.5	82	91	86.7
Free ammonia, sewage, . . .	3.5650	3.8342	4.6193	4.6283	4.1617	3.5700	4.203	3.8867
Free ammonia, effluent, . . .	1.2723	1.3176	1.3722	1.2917	1.3134	.9613	.3373	.6493
Per cent. removed, . . .	64	66	70	70	67.5	73	92	83.3
Nitrogen as nitrates, effluent, .	.1445	.1664	.1468	.2319	.1724	.3825	1.085	.7338
Iron, effluent, . . .	2.1042	2.2454	1.8100	1.7633	1.9807	.9200	.3590	.6395

A comparison of the column showing the average results for the four years preceding 1910 with the results for the past year indicates that a very material improvement in the condition of the effluent has been accomplished through the construction of the under-drainage system and the placing of distributors on the surface of the beds during the past three years. The free ammonia in the effluent was less than one-half and the iron less than one-third of the average of the previous four years.

The cost of maintaining the filter-beds, exclusive of the cost of placing distributors on the beds and building two new sludge beds, has been as follows:—

Labor,	\$3,228 06
Supplies and expenses,	125 36
<hr/>	
Total,	\$3,353 42
Cost per million gallons treated,	11 24

The increase in the cost of labor is due to the extra labor required to keep the surface of the beds clear of weeds, on account of the construction of the distributors.

There has been constructed a small shed for the storage of wagons, farming implements, tools, etc., at a cost of \$139.69.

Daily tests of the sewage and effluent, to determine the amount of dissolved oxygen and iron, have been made by the keeper in charge of the beds.

During the preceding two years extensive additions were made to the effective filtering area, the underdrainage system and surface distributors.

Continuing along the same line of improvements, in the past year there have been built carriers with concrete bottoms and plank sides upon 15 of the remaining 17 beds, thereby equipping 22 of the 24 one-acre beds. The total length of carriers constructed was 2,844 feet. Carriers have not been built on the 2 remaining beds, pending the removal of about 3 feet of undesirable filtering material at present on the top of these beds.

Two beds each 150 feet x 200 feet between centres of embankments, with a filtering prism of gravel and coarse sand 5 feet in depth, and an aggregate area of 1.06 acres, together with the necessary manholes, distributing pipes, gates and underdrains, have been constructed at the southeast corner of the filter-beds near the settling tanks. These beds are designed to have sufficient capacity to receive and care for the sludge from two settling basins at the same time, and are to be used for this purpose in place of two of the regular filter-beds which have been used for several years but which were not of sufficient area and not conveniently located.

Work was begun upon the construction of the concrete carriers on May 9, and they were completed on July 2, at a cost of \$2,808.42, or 99 cents per linear foot. Work on the construction of the sludge beds was begun on August 15, and they were completed on November

18, at a total cost of \$4,895.61. All of this work was done by day labor. The total amount expended in improving these beds during the past year has been \$7,704.03, and the total expended during the past three years, \$17,584.87.

ENGINEERING.

The greater portion of the time of the engineering force employed upon matters pertaining to the maintenance and operation of the works has been devoted to the superintendence of the operation of the Venturi meters and of the flow of water from the several reservoirs through the aqueducts; the determination of the quantities of water used in the several municipalities; the tabulation of the records of rainfall as measured at twelve stations on the works, of the elevations of the several storage and distributing reservoirs, and of the pressures in the mains at different points in the Metropolitan District; the making of calculations to determine the yield of the several watersheds, the quantities delivered by the several aqueducts, the quantities pumped at the several pumping stations and the cost of pumping, the testing of coal and oil, and the examination of the pipes to determine the injury from electrolytic action.

Special engineering work done during the year in connection with the maintenance of the works has included the giving of lines and grades and superintending the construction of filter-beds and distributing carriers at the Clinton sewerage filter-beds and of the new drainage system at Lake Cochituate. A survey of Framingham Reservoir No. 3 has been completed, and plans made on a scale of 100 feet to an inch showing the present high-water mark with reference to the lines of the property belonging to the Board; a survey of Framingham Reservoir No. 2, for the purpose of making similar plans, is now in progress; plans upon the same scale have also been completed, showing the existing shore and property lines around Lake Cochituate, and the location of the Sudbury and Cochituate aqueducts with the location of adjoining property lines and the names of present owners.

Appended to this report are tables giving the amount of work done and other information relative to contracts, a series of tables relating

to the maintenance of the Metropolitan Water Works, including the rainfall, yield of sources of supply, consumption of water in the different districts, the number of service pipes, meters and fire hydrants in the Metropolitan Water District, and a summary of statistics for 1910.

Respectfully submitted,

DEXTER BRACKETT,
Chief Engineer.

BOSTON, January 2, 1911.

REPORT OF CHIEF ENGINEER OF SEWERAGE WORKS.

To the Metropolitan Water and Sewerage Board.

GENTLEMEN:— The following is a report of the operations of the Engineering Department of the Metropolitan Sewerage Works for the year ending December 31, 1910.

ORGANIZATION.

The engineering organization during the year has been as follows:—

Division Engineers:

- | | | |
|---------------------|-----|--|
| FREDERICK D. SMITH, | . . | <i>In charge of maintenance and construction,
South Metropolitan System.</i> |
| FRANK I. CAPEN, | . . | <i>In charge of maintenance and construction,
North Metropolitan System.</i> |
| HENRY T. STIFF, | . . | <i>In charge of office and drafting room.</i> |

In addition to the above, there were employed at the end of the year 13 engineering and other assistants.

METROPOLITAN SEWERAGE DISTRICTS.

AREAS AND POPULATIONS.

During the year no changes have been made in the extent of the sewerage districts. The area of the North Metropolitan District remains at 90.50 square miles, and of the South Metropolitan District at 100.87 square miles,— a total, inclusive of water surfaces, of 191.37 square miles. These districts include the whole or parts of 25 cities and towns, as set forth in the following table.

The populations in the table are based on the census of 1910.

Table showing Areas and Estimated Populations within the Metropolitan Sewerage District, as of December 31, 1910.

CITY OR TOWN.		Area (Square Miles).	Estimated Population.
North Metropolitan District.	Arlington,	5.20	11,490
	Belmont,	4.66	5,720
	Boston (portions of),	3.45	103,007
	Cambridge,	6.11	105,920
	Chelsea,	2.24	33,090
	Everett,	3.34	34,310
	Lexington, ¹	5.11	4,140
	Malden,	5.07	45,260
	Medford,	8.35	23,720
	Melrose,	3.73	15,930
	Revere,	5.86	18,870
	Somerville,	3.96	78,500
	Stoneham,	5.50	7,250
	Wakefield,	7.65	11,580
	Winchester,	5.95	9,480
South Metropolitan District.	Winthrop,	1.61	10,480
	Woburn,	12.71	15,470
		90.50	534,217
	Boston (portions of),	20.39	183,000
	Brookline,	6.81	28,410
	Dedham, ¹	9.40	9,350
	Hyde Park,	4.57	15,740
	Milton,	12.59	8,060
	Newton,	16.88	40,420
	Quincy,	12.56	33,320
	Waltham,	13.63	28,220
	Watertown,	4.04	13,150
		100.87	359,670
Totals,		191.37	893,837

¹ Part of town.

METROPOLITAN SEWERS.

SEWERS PURCHASED AND CONSTRUCTED AND THEIR CONNECTIONS.

During the year no additions by purchase or otherwise have been made within the sewerage districts, so that there are now 101.985 miles of Metropolitan sewers. Of this total, 8.79 miles of sewers, with the Quincy pumping station, have been purchased from cities and towns of the districts, the remaining 93.195 miles of Metropolitan sewers and other works having been constructed by the Metropolitan boards.

The locations, lengths and sizes of these sewers are given in the following tables, together with other data referring to the public and special connections with the system:—

North Metropolitan System.

CITY OR TOWN.	Size of Sewers.	Length in Miles.	Public Connections, December 31, 1910.	SPECIAL CONNECTIONS.	
				Character or Location of Connection.	Number in Operation.
Boston:—					
Deer Island, .	6' 3" to 9',	1.367	4	-	-
East Boston, .	9' to 1',	5.467	24	Shoe factory,	1
Charlestown, .	6' 7"×7' 5" to 1', . . .	3.292	14	Navy Yard,	8
				Alms house,	1
				Club House,	1
Winthrop, . .	9',	2.864	11	Fire Dept. Station, . . .	1
				Private Building,	1
				Bakery,	1
				Rendering works,	1
Chelsea, . . .	8' 4"×9' 2" to 1' 10"×2' 4",	5.123	10	Metropolitan Water Works	
				blow-off,	1
				Chelsea Water Works blow-	
				off,	2
				Metropolitan Water Works	
				blow-off,	1
Everett, . . .	8' 2"×8' 10" to 4' 8"×5' 1",	2.925	6	Cameron Appliance Co., . .	1
				Shultz-Goodwin Co., . . .	1
				Andrews-Wasgatt Co., . . .	1
				Metropolitan Water Works	
Malden, . . .	4' 6"×4' 10" to 1' 3", . .	4.493 ¹	28	blow-off,	1
				Private buildings,	143
Melrose, . . .	4' 6"×4' 10" to 10", . . .	6.099 ²	35	Private buildings,	109
				Factory,	1
Cambridge, . .	5' 2"×5' 9" to 1' 3", . . .	7.167	37	Railroad station,	1
				Slaughter house,	1
				City Hospital,	2
				Tannery,	1
				Slaughter-houses (3), . . .	1
Somerville, . .	6' 5"×7' 2" to 1' 10"×2' 3",	3.471	10	Car-house,	1
				Street railway power house, .	1
				Stable,	1
				Rendering works,	1
Medford, . . .	4' 8"×5' 1" to 10", . . .	5.359	21	Armory building,	1
				Private buildings,	8
				Stable,	1
Winchester, . .	2' 11"×3' 3" to 1' 3", . .	6.428	13	Police sub-station,	1
				Tannery,	4
				Private buildings,	2
Stoneham, . .	1' 3" to 10",	0.010	4	Gelatine factory,	1
Woburn, . . .	1' 10"×2' 4" to 1' 3", . .	0.933	3	Stable,	1
				Railroad station,	1
Arlington, . .	1' 6" to 10",	3.520 ³	35	Glue factory,	1
				Private buildings,	130
Belmont, ⁴ . . .	-	-	3	Railroad station,	1
Wakefield, ⁴ . .	-	-	1	Car-house,	3
Revere, . . .	4' to 3',	0.048	2	Post Office,	1
				-	-
				-	-
				-	-
		58.566 ⁵	261		442

¹ Includes .988 of a mile of sewer purchased from the city of Malden.² Includes .736 of a mile of sewer purchased from the city of Melrose.³ Includes 2.631 miles of sewer purchased from the town of Arlington.⁴ The Metropolitan sewer extends but a few feet into the towns of Belmont and Wakefield.⁵ Includes 2.787 miles of Mystic River valley sewer in Medford, Winchester and Woburn, running parallel with the Metropolitan sewer.

South Metropolitan System.

CITY OR TOWN.	Size of Sewers.	Length in Miles.	Public Connections, December 31, 1910.	SPECIAL CONNECTIONS.	
				Character or Location of Connection.	Number in Operation.
Boston (Back Bay),	6' 6" to 3' 9", . . .	1.500 ¹	13	{ Tufts Medical School, . . . Private house, . . . Administration Building, Boston Park Department, Simmons College buildings, . Art Museum, . . . Abattoir, . . . Chocolate works, . . . Machine shop, . . . Paper mill, . . . Private buildings, . . .	{ 1 1 1 1 2 3 2 1 1 2
Boston (Brighton),	5' 9"×6' 0" to 12", . . .	6.010 ²	12	{	{ 2
Boston (Dorchester).	3'×4' to 2' 6"×2' 7", . . .	2.870 ²	10	{	{ 2
Boston (Roxbury),	6' 6"×7', 4' 0", . . .	1.430	-	-	-
Boston (West Roxbury).	9' 3"×10' 2" to 12", . . .	7.600	9	{ Parental school, Lutheran Evangelical Church, Private buildings, . . .	{ 1 1 4
Brookline, . . .	6' 6"×7' 0" to 8", . . .	2.540 ⁴	12	-	-
Dedham, . . .	4'×4' 1" to 3' 9"×3' 10", . . .	2.350	5	-	-
Hull, . . .	60" pipe, . . .	0.750	-	-	-
Hyde Park, . . .	10' 7"×11' 7" to 4'×4' 1", . . .	4.527	17	{ Mattapan Paper Mills, . . . Private buildings, . . .	{ 1 2
Milton, . . .	11'×12' to 8", . . .	3.600	18	-	-
Newton, . . .	4' 2"×4' 9" to 1' 3", . . .	2.911	6	Private houses, . . .	2
Quincy, . . .	11' 3"×12' 6" to 24" pipe, . . .	6.580	10	-	-
Waltham, . . .	3' 6"×4', . . .	0.001	1	-	-
Watertown, . . .	4' 2"×4' 9" to 12", . . .	0.750 ⁵	6	{ Factories, Stanley Motor Carriage Co., .	{ 2 1
		43.419	119		29

¹ Includes .355 of a mile of sewer purchased from the city of Boston.
² Includes .446 of a mile of pipe and concrete sewers built for the use of the city of Boston; also, .026 of a mile of sewer purchased from the town of Watertown.
³ Includes 1.24 miles of sewer purchased from the city of Boston.
⁴ Includes .158 of a mile of pipe sewer built for the use of the town of Brookline.
⁵ Includes .025 of a mile of sewer purchased from the town of Watertown.

COST OF CONSTRUCTION.

[To December 31, 1910.]

The cost of the 101.985 miles of Metropolitan sewers enumerated above, including six pumping stations, screen-house, electric lift station, siphons and appertaining structures, may be summarized as follows:—

North Metropolitan System,	\$6,521,196 15
South Metropolitan System,	8,792,779 64
	<hr/> \$15,313,975 79

Information relating to areas, populations, local sewer connections and other data for the whole Metropolitan Sewerage District appear in the following table:—

North Metropolitan District.

Area (Square Miles).	Estimated Total Population.	Miles of Local Sewer connected.	Estimated Population contributing Sewage.	Ratio of Contributing Population to Total Population (Per Cent.).	CONNECTIONS MADE WITH METRO- POLITAN SEWERS.	
					Public.	Special.
90.50	534,217	669.07	465,302	87.1	261	442

South Metropolitan District.

100.87	359,670	542.25	230,365	64.0	119	29
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Entire Metropolitan District.

191.37	893,887	1,211.32	695,667	77.8	380	471
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Of the estimated gross population of 893,887 on December 31, 1910, 695,667 representing 77.8 per cent., were on that date contributing sewage to the Metropolitan sewers, through a total length of 1,211.32 miles of local sewers owned by the individual municipalities. These sewers are connected with the Metropolitan System by 380 public and 471 special connections. It appears, also, that there has been during the year an increase of 34.75 miles of local sewers connected with the Metropolitan System, and that 21 public and 8 special connections have been added.

PUMPING STATIONS AND PUMPAGE.

The following table shows the average daily volume of sewage lifted at each of the six Metropolitan pumping stations during the year, as compared with the corresponding volumes for the previous year:—

PUMPING STATION.	AVERAGE DAILY PUMPAGE.			
	Jan. 1, 1909, to Dec. 31, 1909.	Jan. 1, 1910, to Dec. 31, 1910.	Increase during the Year.	
	Gallons. 60,600,000	Gallons. 59,000,000	Gallons. 1,600,000 ¹	Per Cent. 2.6 ¹
Deer Island,				
East Boston,	58,600,000	57,000,000	1,600,000 ¹	2.7 ¹
Charlestown,	32,100,000	34,300,000	2,200,000	6.9
Alewife Brook,	3,358,000	3,585,000	227,000	6.8
Quincy,	4,163,000	4,132,000	31,000 ¹	0.7 ¹
Ward Street (actual gallons pumped), . .	22,700,000	22,900,000	200,000	0.9

¹ Decrease.

CONSTRUCTION.

NORTH METROPOLITAN SYSTEM.

DEER ISLAND PUMPING STATION.

The construction provided for in chapter 566 of the Legislative Acts of 1908 for extensions and additions to the Deer Island pumping station has been practically completed during the year. The additions to the pumping plant, including the 100,000,000-gallon pump, four boilers, economizer and piping, are fully installed, and have been operated in the continuous working service of the house since early in April.

During the year, by-pass channels on the main sewer under the screen-house have been completed by day labor. Contracts for new screening machinery for both the by-pass channel and the main sewer were made with the Hyde Windlass Company of Bath, Me., May 16, 1910. This new screening machinery has been placed by the engineers of the Department; on the by-pass channel, the new screens have been in operation since early in October. On the main sewer, the screens and machinery will be ready for operation early in February.

During the year, two new electric generators, furnished by B. F. Sturtevant Company of Hyde Park, of 17½ kilowatt capacity each, have been placed in the new engine room; new wiring and new electrical fixings and fixtures have been introduced in the new and old engine rooms, the boiler room, coal house and screen rooms. A machine shop has been fitted up at the end of the coal house with small

power engine, lathe, power drills, grinders, work benches, forge and blacksmith's outfit. This work has been placed by the engineers of the Department.

During the year, day-labor forces under the direction of the engineer have placed a masonry floor in the new engine house and a new tiled floor in the new and old engine rooms and screen room. Wooden bulkheads and posts in the old coal house have been replaced during the year by reinforced concrete posts and bulkheads.

Test of Deer Island Engine.

Tests of the 100,000,000-gallon engine at Deer Island, as specified in the contract with the Allis-Chalmers Company, were made November 30 and December 1, 1910. These tests were made under the immediate direction of Frank I. Capen, Division Engineer, and William M. Francis, Mechanical Engineer, for the Metropolitan Sewerage Works, and J. R. Belknap, Mechanical Engineer for the Allis-Chalmers Company.

This engine, pump, piping and four new boilers and appurtenances were furnished by the Allis-Chalmers Company of Milwaukee, Wis., under a contract dated November 3, 1908.

The pump was erected between October, 1909, and February, 1910, and was first operated in February, 1910. By agreement between the Board and the Allis-Chalmers Company it has been operated on the regular service of the station since April, 1910, prior to the official test and acceptance by the Board.

The following tables contain principal dimensions of engine and boilers:—

Principal Dimensions of Engine and Pump.

Diameter H. P. cylinder (inches),	18
Diameter I. P. cylinder (inches),	32
Diameter L. P. cylinder (inches),	46
Stroke of pistons (inches),	30
Diameter of suction (inches),	60
Diameter of discharge (inches),	60
Revolutions per minute,	80 to 104

Principal Dimensions of Boilers.

Steam pressure (pounds),	125
Diameter of shell inside smallest ring (inches),	98
Thickness of plates (inches),	1 $\frac{3}{16}$
Diameter of furnace inside (inches),	48
Length of furnace (feet),	13
Length of tubes (feet),	13
Diameter of tubes (inches),	2 $\frac{1}{2}$
Number of tubes,	130
Length of grate (feet),	6
Width of grate (feet),	4

Contract Requirements.

The contract provides that the engine shall fulfil the following requirements:—

Capacity, 100,000,000 United States gallons per twenty-four hours with lift of 19 feet.

The actual head against which the pump is acting to be measured every fifteen minutes by a mercury or other approved gage at a point near the pump end of the discharge channel. This credits the pump with all friction through the Venturi meter, check valves and discharge channels.

Duty guaranteed, 96,500,000 foot-pounds of work for each 1,000 pounds of commercially dry steam used by the engine and auxiliary pump supplied by the Contractor. Steam containing less than 1 $\frac{1}{2}$ per cent. of entrained water, as determined by calorimeter measurements, to be considered as commercially dry steam.

The pump to discharge into the varying elevations of the tide.

The duration of the test to be twelve hours, starting at low tide, with a minimum lift of 9 feet, and gradually rising to 19 feet at high tide.

The actual elevations in the suction channel to be measured every fifteen minutes by a gage in the suction manhole. The average of all the varying lifts to be used in determining the duty of the pump.

The quantity of sewage lifted to be determined from meter readings taken once every fifteen minutes during the trial by a manometer on the Venturi meter. The sewage to be screened, and to consist of about two-thirds ordinary domestic sewage and about one-

third sea water, introduced into the sewer at convenient points above the station.

The engine to be operated continuously during the twelve hours of the trial, under the conditions before outlined, and supplied with steam of not more than 125 pounds pressure per square inch by gage at the throttle valve.

The trials of the engine to be conducted jointly by the Engineer and a representative of the Contractor.

If the duty determined by the official trials of the engine were found to be less than that guaranteed by the Contractor, the sum of \$500 for each 1,000,000 foot-pounds of work unperformed below the guaranteed duty, and pro rata for fractional parts, would be deducted from the price bid by the Contractor. If the duty shown by the official trials of the engine were 10 per cent. less than that guaranteed in the contract, the Board might reject the engine.

The type and design of the boilers were specified in the contract, so that no formal boiler tests were required.

Trial.

To furnish the 100,000,000 gallons of water required during the test, tide water was allowed to enter the sewer through the tide gates at Malden River. This tide water furnished about one-third of the total quantity required. To regulate the quantity to be pumped to the rate of 100,000,000 gallons per twenty-four hours, the check valve of the No. 1 pump at the station was braced open. No. 1 pump and engine were also braced so that they could not move. By operating the penstock valve on the suction of this pump, water was allowed to flow back from the discharge sewer in sufficient quantity to give the 100,000,000 gallons per twenty-four hours required during the test. The water in the suction sewer was held at approximately elevation 98, and the elevation in the discharge sewer varied with the tide.

Three boilers furnished the steam used during the test. Steam was conveyed to the engine through one of the duplicate lines of 8-inch steam main, and in order that the leakage should be reduced to the minimum, all connections between this duplicate main and auxiliary steam lines were blanked off by plates inserted between flanges of pipes.

The feed water was taken directly from the city main, weighed in

barrels on platform scales and fed to the boilers by the feed pump connected with the engine. For this service a temporary 3-inch pipe line was extended to the economizer.

Quarter-hour observations were made of all pressure gages and other apparatus used in connection with the test. The elevation of water in the discharge channel was determined by a mercury gage, and the quantities of sewage pumped were determined by a manometer attached to the Venturi meter. The height of the water in the suction channel was determined by a hook gage. Calorimeter measurements of the moisture in the steam were made hourly during the test.

All observations were made both by representatives of the Metropolitan Water and Sewerage Board and the Allis-Chalmers Company.

Trial Data and Results.

Date of trial,	November 30 and December 1, 1910
Duration of trial,	12 hours

Average Pressures.

Steam at boilers (pounds),	127.70
Steam at throttle (pounds),	126.50
First receiver (pounds),	20.10
Second receiver (inches of mercury),	5.83
Vacuum,	25.20

Head Pumped against.

Average elevation in suction channel,	98.20
Average net head pumped against,	14.74
Average elevation in discharge channel corrected for losses in discharge pipe, Venturi meter, and check valve,	112.94
Minimum head pumped against,	10.88
Maximum head pumped against,	18.20

Revolutions.

Total revolutions during test,	68,797.00
Average revolutions per minute,	95.55

Useful Work performed by Engine.

Total water pumped (United States gallons per twenty-four hours),	100,700,000
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Water fed to Boilers.

Total water weighed (pounds),	55,987
Deduct leakage from boilers, pipes, valves and waste from calorimeter,	906
Total steam chargeable to engine,	55,081
Average entrainment of moisture in steam entering engine in excess of $1\frac{1}{2}$ per cent. (0.19 per cent.),	105
Total dry steam used by engine (pounds),	54,976

Duty.

Duty on foot-pounds per 1,000 pounds commercially dry steam corrected for losses,	112,800,000
Duty foot-pounds per 1,000 pounds water fed to boilers,	110,753,300

Horse Power and Efficiency.

Average indicated horse power,	391.92
Average water horse power,	260.96
Efficiency per cent.,	66.60
Water per indicated horse power per hour,	11.69

The duty developed by this engine during its tests of 112,800,000 foot-pounds of work for each 1,000 pounds of commercially dry steam used exceeds the duty of 96,500,000 foot-pounds guaranteed by the engine builders in their contract by 16.9 per cent.

The efficiency of the pump and engine developed in the test, and expressed in a ratio of useful work accomplished to indicated steam horse power developed, was 66.6 per cent. This exceeds by 20 per cent. the efficiency developed by other engines in this station.

The new plant, including engine, pump, boiler and appurtenances, operated satisfactorily during the tests, and has continued to give satisfactory results since that date in the regular service of the station.

Except for minor repairs, during the year of probation specified in the contract, the plant is in condition for formal acceptance.

EAST BOSTON PUMPING STATION.

Chapters 556 and 582 of the Acts of 1908 provided for repairs to the East Boston station, burned in April, 1908, and for new engine, boiler and coal houses and wharf, with an additional engine, boilers, piping and connections.

As outlined in the last report contracts for repairs to the old station and construction for the new buildings were made in 1909. The building contracts were fully completed as early as November 1, 1910. On July 15, 1910, a contract was made with the John T. Scully Foundation and Transportation Company for pile wharf, steel floor and coal runs. The work under this contract was completed on November 30, 1910.

The wharf is about 40 feet wide at the northerly end of the coal house and extends along the rear of the house for its entire length, varying in width from 10 to 20 feet. This contract included the placing of two coal runs with steel framing. The wharf is built with spruce piles and spurshores and oak fender piles. These are framed with a capping of steel channel irons and diagonal braces of angle irons. It is intended that the wharf construction shall be fire-proof. To accomplish this, the steel frames and piles are to be surrounded with concrete and the wharf deck to be of reinforced concrete. This concrete work will be done by day labor under the direction of the Engineer. A portion of the wharf deck at the end of the coal house has been placed and some of the piles surrounded by concrete. This work will be completed in the spring. A concrete retaining wall at the easterly end of the coal house, to defend the approach to the wharf, has been placed during the year by day labor.

As stated in last year's report, a contract was made with the Allis-Chalmers Company of Milwaukee for one 100,000,000-gallon centrifugal pump and engine. The parts for this engine arrived about December 1, and are now being erected. The engine may be in condition to operate some time during the month of March.

The foundations for this pump and engine have been constructed by day labor, under the direction of the Engineer, together with the floor of the basement of the new engine room, of concrete reinforced with twisted steel. The main floor of the new engine room was also placed by day labor. It is of framed steel beams surrounded by concrete and covered with a floor of reinforced concrete. The suction channel leading from the pump well to the new engine has been enlarged for a length of 28 feet, and is now equivalent in area to a pipe 60 inches in diameter. This work has been done by day labor.

The boilers mentioned in the last report as contracted for with the

Robb-Mumford Company have arrived, and have been placed on foundations in the new boiler room, and at the date of this report are equipped and connected and will be in condition to use about the first of March.

Two economizers of 144 3-inch tubes each have been furnished and erected in the boiler room by the B. F. Sturtevant Company. The necessary piping and connections between the engine and boilers are to be made at a later date by the Board.

STABLE AND LOCKER BUILDING.

A concrete sea wall has been constructed along the rear of the locker building lot at the corner of Addison and Chelsea streets. The foundations for a stable and locker building 28 feet x 65 feet, two stories high, have been built. The building itself is about half completed.

The foundations and building are of reinforced concrete, including floors and roof. The windows and doors are of steel and the roof will be covered with a terra cotta promenade tile. It is believed that the building will be fire-proof. The work is being done by day labor under the direction of the Engineer.

SOUTH METROPOLITAN SYSTEM.

SEWAGE LIFT AT HOUGH'S NECK, QUINCY.

Chapter 424 of the Acts of 1899, the High-level Sewer Act, provides that the Board shall construct such pumping stations as shall enable the city of Quincy to drain its sewerage systems by gravity into the Metropolitan sewers.

The mayor of Quincy notified the Board of the intention of the city to construct sewers in low areas at Hough's Neck in the vicinity of Island Avenue, the drainage from which will require to be lifted to the High-level Sewer.

Chapter 292 of the Acts of 1910 authorized the Board to expend such sums as may be required, from unexpended balances of appropriations, to construct necessary works to enable the city of Quincy to drain, by gravity, its territory into the High-level Sewer.

The territory for which relief has been requested includes the easterly and southerly ends of Hough's Neck, involving an ultimate area of 170 acres. This district will ultimately be served by about 8 miles of local sewers. At present, about 3 miles of local sewers

are to be built, and it may be many years before more territory will need drainage. The drainage from the area to be sewered at once will be very small. The point at which it will naturally be collected is at the Commonwealth's lot on the westerly side of Island Avenue. This lot is about half a mile distant from the Nut Island screen-house. Provision has been made for lifting this small amount of sewage by an automatic electrically-actuated lift, maintained and operated by the engineers at the Nut Island screen-house. The power for this service is furnished by generators at the Nut Island screen-house.

The works include a concrete storage and pump well holding 50,000 gallons; electrical conduits connecting with the Nut Island screen-house two 6-inch centrifugal pumps of 1,500,000 gallons capacity, each per day actuated by electrical motors; a sewage lift building 14 feet square, covering the pump well, of brick with Quincy granite trimmings and red slate roof.

Contracts for carrying out the work have been made as follows:—

John Cashman & Sons Company, receiving basin, foundations and appurtenances, dated August 29, 1910.

B. F. Sturtevant Company, motors and pumping machinery, dated October 21, 1910.

C. A. Dodge Company, station building, dated November 14, 1910.

At the date of this report the Cashman contract is completed, with the exception of some grading and placing of loam. The building is constructed, the pumps are installed and the plant will be ready to operate in the early spring.

MAINTENANCE.

SCOPE OF WORK AND FORCE EMPLOYED.

The maintenance of the Metropolitan Sewerage System includes the operation of 7 stations and 101.985 miles of Metropolitan sewers, receiving the discharge from 1,211.32 miles of town and city sewers at 380 points, together with the care and study of inverted siphons under streams and in the harbor.

The permanent maintenance force of 148 men includes 88 engineers and other employés at the pumping stations, and 60 men employed on actual sewer maintenance and care of pumping station grounds. In the following two tables the use of the completed systems and other data are shown:—

NORTH METROPOLITAN SYSTEM.

Table showing Cities and Towns delivering Sewage in this System; Approximate Miles of Sewer connected; Estimated Populations and Areas now contributing; Total Areas ultimately to contribute, and Present Populations on Such Areas; Ratios of Present Contributing Areas to Ultimate Areas, and Ratios of Populations now contributing to Present Total Populations.

[Populations estimated as of December 31, 1910.]

CITIES AND TOWNS.	Miles of Local Sewer connected.	Separate or Combined.	Number of Connections with Local Sewers.	Estimated Number of Persons served by Each House Connection. ¹	Estimated Population now contributing Sewage.	Estimated Present Population.	Estimated Area now contributing Sewage.	Area ultimately to contribute Sewage.	Ratio of Contributing Population to Present Total Population.	Ratio of Contributing Area to Ultimate Area.
Boston (Deer Island),	0.70	Separate,	—	4.30	1,347 ²	1,347 ²	Sq. Miles.	Sq. Miles.	Per Cent.	Per Cent.
Winthrop,	29.92	Separate,	2,393	12.50	10,290	10,480	1.29	1.61	108.2	80.1
Boston (East Boston),	30.43	Separate and combined,	4,593	12.50	57,100	59,840	1.08	2.18	95.4	49.5
Chelsea,	29.21 ³	Separate and combined,	3,332 ⁴	9.00	29,990	33,090	1.10	2.24	90.6	49.1
Everett,	43.80	Separate and combined,	4,289	6.55	28,095	34,310	1.89	3.24	81.9	56.6
Malden,	55.64	Separate,	5,441	6.10	33,190	45,260	2.81	5.07	73.3	55.4
Melrose,	35.91	Separate,	2,785	4.60	12,810	15,930	1.75	3.73	80.4	46.9
Boston (Charlestown),	21.16	Separate and combined,	5,272	7.90	41,650	41,820	0.67	1.27	99.6	52.8
Cambridge,	144.03	Separate and combined,	15,299	6.85	104,795	105,920	4.99	6.11	98.9	81.7
Somerville,	94.59	Separate and combined,	14,217	5.45	77,480	78,500	3.33	3.96	98.7	84.1
Medford,	52.92	Separate,	3,970	5.75	22,825	23,720	2.83	8.35	96.2	33.9
Winchester,	24.05	Separate,	1,236	5.40	9,475	9,480	1.17	5.95	70.4	19.7
Woburn,	13.95 ⁵	Separate,	1,065	5.70	6,075	15,470	0.95	12.71	39.2	7.5
Stoneman,	11.75	Separate,	744	4.70	3,495	7,250	0.63	5.50	48.2	11.5
Arlington,	23.64	Separate,	1,268	6.10	7,735	11,490	1.72	5.20	67.3	33.1
Belmont,	13.40	Separate,	568	6.50	4,195 ⁶	5,720	1.05	4.66	73.3	22.5
Wakefield,	11.75	Separate,	560	5.70	3,190	11,580	0.46	7.65	27.5	6.0
Lexington, ⁷	—	—	—	—	—	4,140	—	5.11	—	—
Revere,	32.22	Separate,	2,436	5.90	14,370	18,870	1.77	5.86	76.2	30.2
Totals,	669.07	—	69,443	6.70	465,302	534,217	29.49	90.50	87.1	32.6

¹ Estimated from assessors' statement of the number of houses in each city or town, on April 1, 1910, and the population from census of 1910.

² Estimated by Superintendent James H. Cronin of the Institution on Deer Island.

³ The districts connecting at Cypress Street, Revere Beach Parkway, Springvale Avenue, Willoughby, Bellingham, Highland, Hawthorn and Spruce streets are now contributing sewage.

⁴ Estimated.

⁵ Exclusive of Mystic River valley sewer and tanneries.

⁶ Including 2 connections with McLean Hospital, having an estimated population of 503.

⁷ Lexington not connected.

SOUTH METROPOLITAN SYSTEM.

Table showing Cities and Towns delivering Sewage to this System; Approximate Miles of Sewer connected; Estimated Populations and Areas now contributing; Total Areas ultimately to contribute, and Present Populations on Such Areas; Ratios of Present Contributing Areas to Ultimate Areas, and Ratios of Populations now contributing to Present Total Populations.

[Populations estimated as of December 31, 1910.]

CITIES AND TOWNS.	Miles of Local Sewer connected.	Separate or Combined.	Number of Connections with Local Sewers.	Estimated Number of Persons served by Each House Connection. ¹	Estimated Population now contributing Sewage.	Estimated Present Total Population.	Estimated Area now contributing Sewage.	Area ultimately to contribute Sewage.	Ratio of Contributing Population to Present Total Population.	Ratio of Contributing Area to Ultimate Area.
Boston (Back Bay),	24.65	Separate and combined,	1,608	17.00	27,335	27,800	1.24	1.61	98.3	77.0
Boston (Brighton),	55.78	Separate and combined,	2,994	6.20	18,560	27,300	3.17	3.74	68.0	84.8
Brookline,	65.33	Separate and combined,	3,625	7.50	27,190	28,410	3.43	6.81	95.7	50.4
Newton,	110.04	Separate,	5,850	5.90	34,515	40,420	7.10	16.88	85.4	42.3
Watertown,	35.14	Separate,	1,828	5.50	10,055	13,150	1.93	4.04	76.5	47.8
Waltham,	43.14	Separate,	3,439	7.65	26,210	28,220	2.22	13.63	92.9	16.3
Boston (Dorchester),	49.12	Separate and combined,	4,719	7.50	33,390	59,300	2.32	4.89	59.7	47.4
Milton,	9.83	Separate and combined,	4,459	5.50	2,525	8,060	0.63	12.59	31.3	5.0
Hyde Park,	26.24	Separate,	1,513	7.60 ²	11,500	15,740	1.28	4.57	73.1	28.0
Dedham,	14.54	Separate,	525	5.40	2,835	9,350 ³	0.73	9.40	30.3	7.8
Boston (Roxbury),	—	—	—	—	—	40,000	—	1.23	—	—
Boston (West Roxbury),	47.83	Separate and combined,	2,751	5.80	16,955 ⁴	28,600	2.29	8.92	59.3	25.7
Quincy,	60.61	Separate,	3,263	5.30	17,295	33,320	2.80	12.56	51.9	22.3
Totals,	542.25	—	32,574	7.10	230,365 ⁵	359,670	29.14	100.87	64.0	28.9

¹ Estimated from assessors' statement of the number of houses in each city or town, on April 1, 1910, and the population from census of 1910.
² Estimated by City Engineer. ³ Including connection with Institution at Austin Farm, having an estimated population of 1,000.
⁴ Part of town not included in Metropolitan Sewerage District. ⁵ Corrected from former estimates by census of 1910.

CAPACITY AND RESULTS.

The following tables summarize the pumping records for the year for the Metropolitan sewerage stations:—

NORTH METROPOLITAN SYSTEM.

Deer Island Pumping Station.

At this station are four submerged centrifugal pumps with impellers or wheels 8.25 feet in diameter, driven by triple-expansion engines of the Reynolds-Corliss type.

Contract capacity of 1 pump: 100,000,000 gallons, with 19-foot lift.

Contract capacity of 3 pumps: 45,000,000 gallons each, with 19-foot lift.

Average duty for the year: 42,300,000 foot-pounds.

Average quantity raised each day: 59,000,000 gallons.

Force employed: 4 engineers, 4 firemen, 3 oilers, 3 screenmen and 1 relief screenman.

Coal used: Georges Creek, Pocahontas and New River, costing from \$3.815 to \$4.13 per gross ton.

Table of Approximate Quantities, Lifts and Duties at the Deer Island Pumping Station of the North Metropolitan System.

MONTHS.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1910.						
January,	2,662,200,000	85,900,000	58,100,000	134,700,000	11.92	45,200,000
February,	2,394,900,000	85,500,000	54,700,000	117,200,000	12.70	45,700,000
March,	2,298,600,000	74,100,000	49,600,000	135,100,000	11.12	41,000,000
April,	1,677,200,000	55,909,000	46,500,000	72,900,000	11.24	40,700,000
May,	1,605,700,000	51,800,000	43,300,000	65,000,000	10.83	39,000,000
June,	1,909,800,000	63,700,000	43,800,000	109,600,000	11.77	54,300,000
July,	1,525,000,000	49,200,000	36,600,000	64,500,000	10.09	41,300,000
August,	1,437,800,000	46,400,000	38,800,000	59,700,000	10.09	36,100,000
September,	1,382,900,000	46,100,000	36,000,000	62,200,000	10.03	41,200,000
October,	1,460,400,000	47,100,000	39,100,000	52,100,000	9.97	42,000,000
November,	1,519,000,000	50,600,000	34,300,000	103,800,000	10.90	42,100,000
December,	1,596,000,000	51,500,000	36,000,000	107,400,000	10.16	38,500,000
Total,	21,460,500,000	—	—	—	—	—
Average,	—	59,000,000	43,100,000	90,400,000	10.90	42,300,000

East Boston Pumping Station.

At this station are three submerged centrifugal pumps, with impellers or wheels 8.25 feet in diameter, driven by triple-expansion engines of the Reynolds-Corliss type.

Contract capacity of pumps: 45,000,000 gallons each, with 19-foot lift.
Average duty for the year: 45,500,000 foot-pounds.
Average quantity raised each day: 57,000,000 gallons.
Force employed: 4 engineers, 4 firemen, 3 oilers, 3 screenmen, 1 relief screenman and 3 helpers.
Coal used: New River, costing from \$3.545 to \$4.20 per gross ton.

Table of Approximate Quantities, Lifts and Duties at the East Boston Pumping Station of the North Metropolitan System.

MONTHS.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1910.						
January,	2,600,200,000	83,900,000	56,100,000	132,700,000	15.75	50,200,000
February,	2,338,900,000	83,500,000	52,700,000	115,200,000	15.45	45,600,000
March,	2,236,600,000	72,100,000	47,600,000	133,100,000	15.59	49,000,000
April,	1,617,200,000	53,900,000	44,500,000	70,900,000	15.23	47,700,000
May,	1,543,700,000	49,800,000	41,300,000	63,000,000	15.36	47,800,000
June,	1,849,800,000	61,700,000	41,800,000	107,600,000	15.36	43,000,000
July,	1,463,000,000	47,200,000	34,600,000	62,500,000	14.78	35,900,000
August,	1,375,800,000	44,400,000	36,800,000	57,700,000	14.98	46,300,000
September,	1,322,900,000	44,100,000	34,000,000	60,200,000	15.08	45,800,000
October,	1,398,400,000	45,100,000	37,100,000	50,100,000	15.15	45,500,000
November,	1,459,000,000	48,600,000	32,300,000	101,800,000	14.70	48,100,000
December,	1,534,000,000	49,500,000	34,000,000	105,400,000	15.16	41,400,000
Total,	20,739,500,000	-	-	-	-	-
Average,	-	57,000,000	41,100,000	88,400,000	15.22	45,500,000

Charlestown Pumping Station.

At this station are three submerged centrifugal pumps, two of them having impellers or wheels 7.5 feet in diameter, the other 8.25 feet in diameter. They are driven by triple-expansion engines of the Reynolds-Corliss type.

Contract capacity of pumps: two, 22,000,000 gallons each, with 11-foot lift; one, 60,000,000 gallons, with 8-foot lift.

Average duty for the year: 55,500,000 foot-pounds.

Average quantity raised each day: 34,300,000 gallons.

Force employed: 4 engineers, 4 firemen, 3 oilers, 3 screenmen and 1 relief screenman.

Coal used: New River, costing from \$3.835 to \$3.90 per gross ton.

Table of Approximate Quantities, Lifts and Duties at the Charlestown Pumping Station of the North Metropolitan System.

MONTHS.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1910.						
January,	1,383,600,000	44,600,000	32,300,000	69,300,000	8.60	60,900,000
February,	1,276,000,000	45,600,000	36,000,000	63,200,000	9.99	56,200,000
March,	1,167,600,000	37,700,000	26,100,000	69,400,000	10.79	55,100,000
April,	1,041,000,000	34,700,000	27,200,000	47,600,000	10.63	57,800,000
May,	978,200,000	31,600,000	25,200,000	41,700,000	9.49	62,300,000
June,	1,130,600,000	37,700,000	29,000,000	53,200,000	8.49	55,700,000
July,	963,100,000	31,100,000	25,100,000	39,500,000	8.25	53,700,000
August,	858,700,000	27,700,000	22,900,000	35,800,000	8.16	50,100,000
September,	879,100,000	29,300,000	23,800,000	39,100,000	8.20	53,500,000
October,	853,900,000	27,500,000	22,400,000	31,500,000	8.12	53,100,000
November,	929,900,000	31,000,000	22,400,000	56,100,000	8.30	53,500,000
December,	1,008,600,000	32,600,000	23,200,000	55,000,000	8.34	54,300,000
Total,	12,470,300,000	-	-	-	-	-
Average,	-	34,300,000	26,300,000	50,100,000	8.95	55,500,000

Alewife Brook Pumping Station.

The plant at this station consists of the original installation of small commercial pumps and engines, *i.e.*, two 9-inch Andrews vertical centrifugal pumps, with direct-connected compound marine engines, together with the recent additions. The latter consists of a specially designed engine of the vertical cross-compound type, having between the cylinders a centrifugal pump rotating on a horizontal axis.

Contract capacity of the two original pumps: 4,500,000 gallons each, with 13-foot lift.

Contract capacity of new pump: 13,000,000 gallons, with 13-foot lift.

Average duty for the year: 18,600,000 foot-pounds.

Average quantity raised each day: 3,585,000 gallons.

Force employed: 3 engineers, 1 relief engineer, 2 screenmen, and 1 relief screenman.

Coal used: New River, Pocahontas and Elk Garden, costing from \$4.23 to \$4.73 per gross ton.

Table of Approximate Quantities, Lifts and Duties at the Alewife Brook Pumping Station of the North Metropolitan System.

MONTHS.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1910.						
January,	198,550,000	6,437,000	4,201,000	9,453,000	12.68	27,000,000
February,	200,420,000	7,158,000	5,300,000	8,701,000	12.84	29,200,000
March,	196,397,000	6,335,000	3,380,000	9,055,000	12.81	26,100,000
April,	108,037,000	3,601,000	2,928,000	5,170,000	12.70	18,600,000
May,	92,462,000	2,963,000	2,246,000	4,260,000	12.79	16,900,000
June,	100,849,000	3,362,000	2,162,000	5,753,000	12.75	18,300,000
July,	74,214,000	2,394,000	2,036,000	3,079,000	12.89	15,600,000
August,	61,511,000	1,984,000	1,742,000	2,786,000	12.89	14,400,000
September,	62,496,000	2,083,000	1,700,000	3,380,000	12.88	14,200,000
October,	60,063,000	1,938,000	1,580,000	2,550,000	12.92	13,700,000
November,	70,079,000	2,336,000	1,952,000	4,677,000	12.94	14,300,000
December,	75,343,000	2,430,000	1,868,000	5,300,000	12.96	14,300,000
Total,	1,300,421,000	-	-	-	-	-
Average,	-	3,585,000	2,591,000	5,347,000	12.84	18,600,000

SOUTH METROPOLITAN SYSTEM.

Ward Street Pumping Station.

At this station are two vertical, triple-expansion pumping engines, of the Allis-Chalmers type, operating reciprocating pumps, the plungers of which are 48 inches in diameter with a 60-inch stroke.

Contract capacity of pumps: 50,000,000 gallons each, with 45-foot lift.

Average duty for the year: 82,500,000 foot-pounds.

Average quantity raised each day: 22,900,000 gallons.

Force employed: 4 engineers, 4 firemen, 4 oilers, 4 assistant engineers, 1 machinist and 1 laborer.

Coal used: New River, costing from \$4.095 to \$4.30 per gross ton.

Table of Approximate Quantities, Lifts and Duties at the Ward Street Pumping Station of the South Metropolitan System.

MONTHS.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1910.						
January,	982,800,000	31,700,000	18,700,000	60,900,000	40.73	98,400,000
February,	887,200,000	31,700,000	24,300,000	44,400,000	41.11	101,000,000
March,	959,000,000	30,900,000	24,100,000	45,200,000	41.23	97,000,000
April,	697,900,000	23,300,000	20,100,000	28,000,000	40.21	81,300,000
May,	659,500,000	21,300,000	17,500,000	27,100,000	40.11	82,700,000
June,	727,000,000	24,200,000	17,500,000	37,100,000	39.94	85,000,000
July,	621,100,000	20,000,000	16,000,000	28,500,000	39.73	82,600,000
August,	534,500,000	17,200,000	14,200,000	21,300,000	39.28	74,500,000
September,	532,100,000	17,700,000	15,200,000	23,300,000	39.49	75,000,000
October,	569,900,000	18,400,000	15,200,000	20,300,000	39.42	69,200,000
November,	596,900,000	19,900,000	16,000,000	39,200,000	39.50	73,400,000
December,	591,600,000	19,100,000	16,300,000	33,600,000	39.52	69,500,000
Total,	8,359,500,000	-	-	-	-	-
Average,	-	22,900,000	17,900,000	34,100,000	40.02	82,500,000

Records from plunger displacement.

Average slip for the year about 10.4 per cent.

Quincy Pumping Station.

At this station are two compound condensing Deane pumping engines and one Lawrence centrifugal pump driven by a Sturtevant compound condensing engine.

Contract capacity of pumps: 3,000,000 Deane; 5,000,000 Deane; 10,000,000 Lawrence centrifugal.

Average duty for the year: 33,967,000 foot-pounds.

Average quantity raised each day: 4,132,000 gallons.

Force employed: 3 engineers, 1 relief engineer, 2 screenmen and 1 relief screenman.

Coal used: Cumberland, costing from \$3.93 to \$4.50 per gross ton.

Table of Approximate Quantities, Lifts and Duties at the Quincy Pumping Station of the South Metropolitan System.

MONTHS.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1910.						
January,	169,784,000	5,477,000	3,980,000	7,720,000	23.16	33,100,000
February,	160,154,000	5,720,000	4,980,000	6,665,000	23.12	35,500,000
March,	185,923,000	5,998,000	5,015,000	7,290,000	23.35	37,200,000
April,	147,770,000	4,926,000	4,450,000	5,175,000	21.24	40,100,000
May,	139,120,000	4,488,000	4,010,000	5,230,000	21.27	40,100,000
June,	119,680,000	3,989,000	3,620,000	4,620,000	21.29	36,700,000
July,	105,690,000	3,409,000	3,025,000	3,635,000	21.26	33,600,000
August,	96,505,000	3,113,000	2,740,000	3,460,000	21.21	31,700,000
September,	83,485,000	2,950,000	2,740,000	3,235,000	21.22	29,600,000
October,	89,505,000	2,887,000	2,660,000	3,420,000	21.18	29,800,000
November,	97,015,000	3,234,000	2,830,000	3,630,000	21.13	31,200,000
December,	105,325,000	3,398,000	3,025,000	3,940,000	21.20	29,000,000
Total,	1,504,956,000	—	—	—	—	—
Average,	—	4,132,000	3,590,000	4,835,000	21.72	33,967,000

Nut Island Screen House.

The plant at this house includes two sets of screens in duplicate, actuated by small reversing engines of the Fitchburg type. Two vertical Deane boilers, 80 horse-power each, operate the engines, provide heat for the house and burn materials intercepted at the screens.

Average quantity of sewage passing screens daily, 39,600,000 gallons.

Total materials intercepted at screens during the past year, 1,043.3 cubic yards.

Materials intercepted per million gallons of sewage discharged, 1.95 cubic feet.

Force employed: 3 engineers, 1 relief engineer, 3 screenmen and 1 relief screenman.

Coal used: New River and Cumberland, costing from \$3.98 to \$4.05 per gross ton.

COST OF PUMPING.

In the following tables the total cost of pumping and the rate per million foot-gallons at each of six pumping stations are shown in detail:—

Average Cost per Million Foot-gallons for Pumping at the Deer Island Station.

Volume (21,469.5 Million Gallons) \times Lift (10.90 Feet) = 234,017.6 Million Foot-gallons.

ITEMS.	Cost.	Cost per Million Foot-gallons.
Labor,	\$12,612 60	\$0.05390
Coal,	10,383 31	.04437
Oil,	384 19	.00164
Waste,	190 95	.00082
Water,	1,360 80	.00581
Packing,	303 25	.00130
Miscellaneous supplies and renewals,	2,047 94	.00875
Totals,	\$27,283 04	\$0.11659 ¹
Labor at screens,	-	.01222

¹ The increased cost of pumping over the record for the preceding year is due to the unusual conditions of operation, occasioned by the installation during the year of a new pumping engine and new sewage screens, necessitating modification of channels and plant; the labor thereon requiring the use of extra materials, increased consumption of coal for hoisting materials and almost continuous operation of the lighting plant, and other incidental expenses of which the amounts cannot be readily estimated.

Average Cost per Million Foot-gallons for Pumping at the East Boston Station.

Volume (20,739.5 Million Gallons) \times Lift (15.22 Feet) = 315,655.2 Million Foot-gallons.

ITEMS.	Cost.	Cost per Million Foot-gallons.
Labor,	\$15,596 57	\$0.04941
Coal,	11,198 22	.03547
Oil,	320 51	.00102
Waste,	102 39	.00032
Water,	1,644 00	.00521
Packing,	50 24	.00016
Miscellaneous supplies and renewals,	1,067 59	.00338
Totals,	\$29,979 52	\$0.09497
Labor at screens,	-	.00898

*Average Cost per Million Foot-gallons for Pumping at the Charlestown Station.*Volume (12,470.3 Million Gallons) \times Lift (8.95 Feet) = 111,699.2 Million Foot-gallons.

ITEMS.	Cost.	Cost per Million Foot-gallons.
Labor,	\$11,413 18	\$0.10226
Coal,	3,910 61	.03504
Oil,	199 85	.00179
Waste,	98 70	.00088
Water,	453 60	.00406
Packing,	40 40	.00036
Miscellaneous supplies and renewals,	642 41	.00576
Totals,	\$16,758 25	\$0.15015
Labor at screens,	-	.02538

*Average Cost per Million Foot-gallons for Pumping at the Alewife Brook Station.*Volume (1,300.4 Million Gallons) \times Lift (12.84 Feet) = 16,697.1 Million Foot-gallons.

ITEMS.	Cost.	Cost per Million Foot-gallons.
Labor,	\$5,695 86	\$0.34113
Coal,	1,569 76	.09401
Oil,	149 08	.00893
Waste,	76 50	.00458
Water,	254 20	.01523
Packing,	60 63	.00363
Miscellaneous supplies and renewals,	556 85	.03335
Totals,	\$8,362 88	\$0.50086
Labor at screens, oiling and miscellaneous services,	-	.11214

*Average Cost per Million Foot-gallons for Pumping at the Ward Street Station.*Volume (8,359.5 Million Gallons) \times Lift (40.02 Feet) = 334,547 Million Foot-gallons.

ITEMS.	Cost.	Cost per Million Foot-gallons.
Labor,	\$14,136 76	\$0.04226
Coal,	7,575 98	.02264
Oil,	304 28	.00091
Waste,	36 08	.00010
Water,	1,390 80	.00416
Packing,	126 68	.00038
Miscellaneous supplies and renewals,	1,645 76	.00492
Totals,	\$25,216 34	\$0.07537
Labor at screens,	-	.01306

Average Cost per Million Foot-gallons for Pumping at the Quincy Station.

Volume (1,505.0 Million Gallons) \times Lift (21.72 Feet) = 32,689 Million Foot-gallons.

ITEMS.	Cost.	Cost per Million Foot-gallons.
Labor,	\$4,733 18	\$0.14480
Coal,	1,511 02	.04622
Oil,	35 59	.00109
Waste,	15 18	.00048
Water,	225 02	.00688
Packing,	33 11	.00101
Miscellaneous supplies and renewals,	573 21	.01754
Totals,	\$7,126 93	\$0.21802
Labor at screens, oiling and miscellaneous services,	-	.04772

Coal for use at the several stations has been purchased as follows:—

	GROSS TONS, BITUMINOUS COAL.							Contract Price per Gross Ton. ¹
	Deer Island Pumping Station.	East Boston Pumping Station.	Charlestown Pumping Station.	Alewiffe Brook Pumping Station.	Ward Street Pumping Station.	Quincy Pumping Station.	Nut Island Screen House.	
Staples Coal Company,	-	-	672.3	-	-	-	-	\$3 64
New England Coal and Coke Company,	-	1,603.79	-	-	-	-	-	3 69
Staples Coal Company,	899.8	-	-	-	-	-	190	3 74
New England Coal and Coke Company,	-	-	318.0	-	-	-	-	3 90
Eastern Coal Company,	-	300.00	-	-	-	-	-	4 00
Staples Coal Company,	639.5	-	-	-	-	-	-	4 04
Staples Coal Company,	-	-	-	-	1,421.32	-	-	4 09
New England Coal and Coke Company,	-	780.11	-	-	-	-	-	4 10
Neponset River Coal Company,	-	-	-	-	-	328.85	-	4 15
Eastern Coal Company,	-	191.56	-	-	-	-	-	4 20
Metropolitan Coal Company,	1,519.0	-	-	-	-	-	200	4 20
New England Coal and Coke Company,	-	-	-	225.41	-	-	-	4 25
Staples Coal Company,	-	-	-	-	399.33	-	-	4 29
Metropolitan Coal Company,	-	-	-	-	130.66	-	-	4 30
Frost Coal Company,	-	-	-	-	-	66.65	-	4 50
New England Coal and Coke Company,	-	-	-	179.74	-	-	-	4 55
Staples Coal Company,	-	-	-	-	74.00	-	-	4 55
Total gross tons,	3,058.3	2,875.46	990.3	405.15	2,025.31	395.50	390	-
Average price per gross ton,	\$4 03	\$3 87	\$3 72	\$4 38	\$4 16	\$4 21	\$3 98	-

¹ These prices are given without adjustments for quality.

NORTH METROPOLITAN SYSTEM.**SIPHON UNDER ALEWIFE BROOK.**

The pipe siphons under Alewife Brook, fully described in the last annual report, were finished and put in operation on January 26, 1910. Occasional flushing is found necessary to maintain these siphons.

PIPE UNDER CAMBRIDGE SUBWAY.

The siphon on the Cambridge branch of the Metropolitan sewer, under the subway at Portland Street, fully described in the last report, was completed by the Elevated Railway Company on January 11, 1910.

Since that date this siphon has been successfully operated by the maintenance force. It has required flushing and cleaning as often as twice a week.

CHANGES IN LOCATION OF METROPOLITAN SEWER AT CAMBRIDGE SUBWAY, ELIOT SQUARE, CAMBRIDGE.

Under authority of chapter 520, Acts of 1906, the Boston Elevated Railway Company, with the approval of the Board, relocated during the year a length of Metropolitan sewer between stations 33 + 55 and 38 + 25 of section 30 of the Cambridge branch of the North Metropolitan System.

This length is located in Eliot Street and Eliot Square. The Metropolitan sewer in that vicinity is 2 feet 10 inches wide and 3 feet high, of a modified horseshoe section. The relocation is west of the original sewer, in Murray Street and lands of the Elevated Railway Company. For a length of 340 feet in Murray Street the relocated sewer is 2 feet 10 inches wide by 3 feet 6 inches in height, of a modified horseshoe section. From Murray Street to Eliot Street, in private lands for a length of about 320 feet, two lines of cast-iron pipe, 24 inches and 30 inches in diameter, embedded in concrete, are substituted for the masonry sewer. This length passes under the incline approach to the subway. For a length of about 100 feet in Murray Street, and for the whole length in private land, the sewer is built on a pile foundation. The whole length of the detour is 660 linear feet, replacing 470 feet of original Metropolitan sewer.

The abandoned length of Metropolitan sewer in Eliot Square and Eliot Street was bulkheaded and filled with sand.

The introduction of this detour on the line of the Metropolitan sewer avoids siphoning the sewer under the subway.

The work was started by the Railway Company early in July and completed in September.

DRAINAGE FROM TANNERIES, GELATINE AND GLUE WORKS IN WINCHESTER, WOBURN AND STONEHAM.

During the year, 5 men have been employed continuously in cleaning, flushing and brushing the Metropolitan sewers in Winchester, Woburn and Stoneham above Grove Street in West Medford, near the Winchester line.

This is the territory from which large amounts of tannery and other heavy drainage are received into the Metropolitan System. The amount of this drainage is so great that during the year the Board has found it necessary to require the introduction of settling tanks of substantial size on all connections for tanneries, gelatine and glue works, both on Metropolitan and local sewers within this territory.

The ten tanneries in Winchester, Woburn and Stoneham so connected and regulated have a maximum daily capacity of 5,400 hides. About the first of this year these tanneries were handling 2,850 hides.

Gelatine and glue works in Winchester and Stoneham handle nearly 1,500 tons of raw stock.

All of the manufactories excepting two have settling tanks in use at the date of this report. These two are constructing tanks, and will have them in operation as early as the coming spring.

In the accompanying table (No. 1) is outlined the size of tanks, date of introduction and sludge already handled for the portion of the year they have been operated. It appears that about 3,000 cubic yards of semi-liquid sludge have been settled out during the part of the year tanks have been in operation. The table also indicates that when all tanks are in use and all tanneries are operating at full capacity about 8,000 cubic yards of semi-liquid sludge may be intercepted during the year.

Most of these large manufacturers have independent water supplies. The amounts of drainage measured after leaving the settling

basins are outlined in the following table (No. 2), which indicates that for considerable periods during the day a continuous sewage flow from the tanneries approximates a rate of 3,000,000 gallons per day, or nearly half the carrying capacity of all the Metropolitan sewers in the territory, and that for smaller periods it considerably exceeds one-half the carrying capacity of the sewers.

No. 1. — *Table of Semi-fluid Sludge removed from Settling Basins at the Tanneries, Gelatine and Glue Works in Winchester, Woburn and Stoneham.*

LOCATION OF BASIN.	Basin put in Operation.	Inside Measurement of Basin (Feet).	Number of Times cleaned during Year to Jan. 1, 1911.	Average Quantity Semi-fluid Sludge removed (Cubic Yards).	Total Quantity Semi-fluid Sludge removed to Jan. 1, 1911 (Cubic Yards).	Estimated Quantity Semi-fluid Sludge to be removed Yearly (Cubic Yards).
Beggs & Cobb, Basin No. 1, .	Jan. 15, 1910	47.0 × 23.0	15	92	1,380	1,500
Beggs & Cobb, Basin No. 2, .	May 9, 1910	47.0 × 23.0	2	93	186	500
American Hide and Leather Company, Factory E.	Aug. 1, 1910	48.3 × 23.0	1	70	70	300
American Hide and Leather Company, Factory D.	Nov. 15, 1910	48.0 × 23.1	None	-	-	300
Cottle Leather Company, . .	July 15, 1910	49.0 × 23.2	5	72	360	800
B. F. Kimball & Co., . . .	Dec. 10, 1910	47.2 × 23.0	None	-	-	500
E. Cummings Leather Company.	Nov. 1, 1910	45.9 × 22.6	1	34	34	300
W. P. Fox & Sons,	July 12, 1910	47.8 × 22.6	4	60	240	700
T. F. Boyle & Co.,	Sept. 15, 1910	48.1 × 23.1	1	92	92	500
Champion Tanning Company, .	Not completed	46.8 × 22.9	None	-	-	200
Stoneham Tanning Company, .	Not completed	-	-	-	-	1,200
American Glue Company, . .	Oct. 1, 1910	47.1 × 23.0	1	90	90	400
Winchester Manufacturing Company.	1902 {	{ 35.5 × 24.7 67.2 × 12.0 }	7	64	448	600
Total,	-	-	-	-	2,900	7,800

No. 2. — *Weir Measurements of Manufacturing Drainage entering the Metropolitan Sewer from Settling Basins at Tanneries, Gelatine and Glue Works in Winchester, Woburn and Stoneham.*

NAME.	Weir Measurements (Gallons per 24 Hours).		Maximum Rate of Flow (Gallons per 24 Hours). 1910.	Average Rate of Flow for Nine-hour Day Period (8 A.M. to 5 P.M.) (Gallons per 24 Hours). 1910.	Estimated Per Cent. of Present Business to Maximum Capacity.	Estimated Rate of Flow for Nine-hour Day Period of Maximum Business Capacity (Gallons per 24 Hours).
	1909.	1910.				
Beggs & Cobb, Basin No. 1,	213,000	127,000	565,000	266,700	66%	400,000
Beggs & Cobb, Basin No. 2,		57,000	465,000	112,400	66%	170,000
American Hide and Leather Company, Factory E.	40,000 ¹	40,000	87,000	59,000	66%	90,000
American Hide and Leather Company, Factory D.	50,000 ¹	2,000 ¹	150,000 ¹	2,000 ¹	-	75,000
Cottle Leather Company,	50,000 ¹	1,000 ¹	150,000 ¹	1,000 ¹	-	100,000
B. F. Kimball & Co.,	75,000 ¹	75,000	292,000	157,100	100	170,000
E. Cummings Leather Company, . .	52,000 ¹	52,000	141,000	100,100	80	125,000
W. P. Fox & Sons,	80,000 ¹	66,000	356,000	124,300	57	220,000
T. F. Boyle & Co.,	120,000 ¹	116,000	458,000	254,900	100	275,000
Champion Tanning Company, . . .	50,000 ¹	38,000	142,000	72,300	22	125,000
Stoneham Tanning Company, . . .	150,000 ¹	100,000 ¹	500,000 ¹	250,000 ¹	50	500,000
American Glue Company,	134,000	83,000	259,000	60,000	100	150,000
Winchester Manufacturing Company, .	158,000	145,000	691,000	294,000	100	300,000
Total,	1,172,000	902,000	4,256,000	1,753,800	-	2,700,000

¹ Estimated.² Not tanning.

SOUTH METROPOLITAN SYSTEM.

SOUTH METROPOLITAN OUTFALLS.

The 60-inch outfall pipes in the harbor have been in operation six years at the date of this report. These pipes are in normal condition and free from deposit. During the past year the average flow through them has been 39,600,000 gallons of sewage per day, with a maximum rate of 141,000,000 gallons in the month of January, 1910.

Material Intercepted at the Screens.

The material intercepted at the screens at the North Metropolitan sewerage stations, consisting of rags, paper and other floating mat-

ters, has during the year amounted to 2,335 cubic yards. This is equivalent to 2.7 cubic feet for each million gallons of sewage pumped at Deer Island.

The material intercepted at the screens at the South Metropolitan sewerage stations has amounted to 2,312 cubic yards, equal to 4.3 cubic feet per million gallons of sewage delivered at the outfall works at Nut Island.

Studies of sewage flows in the Metropolitan sewers, siphons and outfall pipes indicate that they are free from deposit.

Respectfully submitted,

WM. M. BROWN,
Chief Engineer of Sewerage Works.

BOSTON, January 2, 1911.

APPENDIX.

APPENDIX No. 1.

CONTRACTS MADE AND PENDING DURING

[NOTE.—The details of contracts made before

1. Number of Contract.	2. WORK.	3. Number of Bids.	AMOUNT OF BID.		6. Contractor.	
			4. Next to Lowest.	5. Lowest.		
1	302 ¹	4,000 tons 60-inch cast-iron water pipes.	1	-	\$98,800 00 ¹	United States Cast Iron Pipe and Foundry Co., Philadelphia, Pa.
2	305 ¹	4,000 tons 60-inch cast-iron water pipes.	1	-	98,800 00 ²	Florence Iron Works, Camden, N. J.
3	306 ¹	200 tons special castings,	2	\$14,640 00	9,400 00 ³	Standard Cast Iron Pipe and Foundry Co., Bristol, Pa.
4	310 ¹	Laying 8,070 feet of 60-inch water pipes in Boston and Newton, Sect. 8 of the Weston Aqueduct supply mains.	10	37,044 50	34,908 60 ³	Charles J. Jacobs Co., Boston.
5	312	40-million-gallon pumping engine.	4	105,700 00	99,769 00 ³	Holly Mfg. Co., Buffalo, N. Y.
6	313 ¹	32 tons 4-inch to 10-inch cast-iron water pipes, 80 tons special castings.	4	5,508 40	4,854 40 ³	United States Cast Iron Pipe and Foundry Co., Philadelphia, Pa.
7	314	Building pressure tunnel about 1,900 feet in length, and laying 500 feet of 80-inch steel pipe and 930 feet of 60-inch pipe in Newton, Sect. 7 of the Weston Aqueduct supply mains.	9	105,201 00	102,150 00 ³	Joseph Hanreddy, Chicago, Ill.
8	315 ¹	159 tons 48-inch cast-iron water pipes.	3	4,173 75 ¹	4,046 55	Warren Foundry and Machine Co., New York, N. Y.
9	316 ¹	Laying 4,720 feet of 16-inch water pipes in Lynn, Sect. 35 of the distribution system.	13	3,968 30	3,953 40 ³	Charles M. Callahan, Boston.
10	317 ¹	210 tons 16-inch cast iron water pipes.	4	5,334 00	5,271 00 ³	United States Cast Iron Pipe and Foundry Co., Philadelphia, Pa.
11	318 ¹	1,405 tons cast-iron water pipes: 425 tons 48-inch, 860 tons 36-inch, 120 tons 30-inch.	3	35,646 25 ⁴ 35,450 25 ³	35,265 50 ^{3,4} 34,579 50 ^{3,5}	United States Cast Iron Pipe and Foundry Co., Philadelphia, Pa.

¹ Contract completed.² Contract based upon this bid.³ Joint bid for 8,000 tons was made for contracts Nos. 302 and 305.

APPENDIX No. 1.

THE YEAR 1910—WATER WORKS.

1910 have been given in previous reports.]

7. Date of Con- tract.	8. Date of Completion of Work.	9. Prices of Principal Items of Contracts made in 1910.	10. Value of Work done Dec. 31, 1910.	
May 14, 1909	Mar. 14, 1910	- -	\$100,931 88	1
May 14, 1909	Sept. 28, 1910	- -	100,549 39	2
May 14, 1909	Apr. 21, 1910	- -	8,757 20	3
Aug. 18, 1909	Aug. 10, 1910	- -	40,525 39	4
Sept. 21, 1909	-	- -	90,000 00	5
Jan. 26, 1910	Aug. 10, 1910	4-inch, 8-inch and 10-inch pipe \$26.70; special cast-ings \$50 per ton of 2,000 pounds.	4,459 29	6
Apr. 28, 1910	-	Top soil excavation, \$0.60 per cu. yd.; top soil surfacing \$0.50 per cu. yd.; earth excavation in open trenches, \$0.50 per cu. yd.; rock excavation in open trenches, \$3.25 per cu. yd.; refilling open trenches and building embankments, \$0.50 per cu. yd.; tunnel excavation, \$25 per lin. ft.; crushing stone, \$0.75 per cu. yd.; concrete masonry in tunnel, \$10 per cu. yd.; concrete masonry in open trench, \$6 per cu. yd.; brick masonry, \$15 per cu. yd.; cement grout in tunnel, \$12 per cu. yd.; cement mortar lining for steel pipe, \$5.50 per lin. ft.; laying 80-inch steel pipe, \$3 per lin. ft.; laying 60-inch cast-iron pipe, \$2 per lin. ft.	65,385 41	7
Mar. 14, 1910	Apr. 30, 1910	48-inch pipe \$26.25 per ton of 2,000 pounds, . .	4,769 04	8
Apr. 22, 1910	June 30, 1910	Laying 16-inch cast-iron pipe, \$0.77 per lin. ft., .	4,518 30	9
Apr. 5, 1910	June 10, 1910	16-inch pipe \$25.10 per ton of 2,000 pounds, . .	5,375 50	10
Apr. 5, 1910	Oct. 15, 1910	48-inch, 36-inch, 30-inch and 20-inch pipe \$25.10 per ton of 2,000 pounds delivered by rail; 36-inch and 30-inch pipe \$24.40 per ton of 2,000 pounds delivered by water.	36,831 30	11

* Delivery by rail.

* Delivery by water.

CONTRACTS MADE AND PENDING DURING THE

1. Number of Con- tract.	2. WORK.	3. Num- ber of Bids.	AMOUNT OF BID.		6. Contractor.
			4. Next to Lowest.	5. Lowest.	
1 319 ¹	110 tons special castings, .	3	\$5,797 00	\$5,390 00 ²	Standard Cast Iron Pipe and Foundry Co., Bristol, Pa.
2 320	2 vertical fire-tube boilers for Chestnut Hill Low Service Pumping Station.	4	10,640 00	10,448 00 ²	Robb-Mumford Boiler Co., Boston.
3 321 ¹	48 tons flexible jointed 48- inch pipe.	3	2,640 00	2,400 00 ²	Warren Foundry and Machine Co., New York, N. Y.
4 322 ¹	Laying 3,780 feet of 16-inch water pipe in Arlington, Sect. 36 of the distribution system.	14	4,403 00	3,971 50 ²	De Vincenzi and Ba- ruffoldi, Boston, Mass.
5 323 ¹	Laying 8,830 feet of 60-inch water pipe in Newton, Sect. 6 of the Weston Aque- duct supply mains.	9	36,055 60 ¹	30,862 50	Cavanagh Bros., Bos- ton, Mass.
6 324 ¹	14 water valves: 5 36-inch hydraulic lift, 7 24-inch and 2 16-inch screw-lift valves.	3	9,856 00	8,607 00 ²	Coffin Valve Co., Bos- ton.
7 325	27.8 tons 24-inch cast-iron water pipes; 103.4 tons special castings.	4	8,420 12	5,931 16 ²	Standard Cast Iron Pipe and Foundry Co., Bristol, Pa.
8 326 ¹	Laying 3,080 feet of 36-inch and 730 feet of 30-inch water pipes in Chelsea.	9	10,560 10	9,751 00 ²	Michael Russo, Boston.
9 327 ¹	5 tons 4-inch and 20 tons 36-inch cast-iron water pipes; 61 tons special cast- ings.	4	3,688 50	3,494 50 ²	United States Cast Iron Pipe and Foundry Co., Phila- delphia, Pa.
10 328	Hand travelling crane, .	2	3,096 00	2,500 00 ²	Niles - Bement - Pond Co., Boston.
11 329	Fuel economizer, . .	2	1,822 00	1,740 00 ²	B. F. Sturtevant Co., Boston.
12 330	Hydro-electric plant at Wa- chusett Dam.	7 ²	71,550 00	71,500 00 ²	S. Morgan Smith Co., York, Pa.
13 332	363 feet 80-inch riveted steel pipe.	4	4,270 00	3,650 00 ²	Hodge Boiler Works, East Boston.
14 16-M ¹	650 tons Davis coal; 250 tons for Arlington Pumping Station; 400 tons for Spot Pond Pumping Station.	4	\$3.83 and \$4.35 per ton.	\$3.70 ² and \$4.20 per ton.	New England Coal and Coke Co., Boston.
15 17-M ¹	7,500 tons Vulcan coal for Chestnut Hill pumping stations.	10	\$3.70 per ton.	\$3.59 ² per ton.	Spring Coal Co., Bos- ton.

¹ Contract completed.² Contract based upon this bid.

YEAR 1910 — WATER WORKS — *Continued.*

7. Date of Con- tract.	8. Date of Completion of Work.	9. Prices of Principal Items of Contracts made in 1910.	10. Value of Work done Dec. 31, 1910.	
Apr. 8, 1910	Dec. 15, 1910	Special castings \$49 per ton of 2,000 pounds, . .	\$5,767 10	1
Apr. 29, 1910	-	Each boiler with vertical seams of inner and outer furnace sheets riveted \$5,224.	10,448 00	2
Apr. 4, 1910	June 10, 1910	48-inch flexible jointed pipe 2½ cents per pound, .	2,191 18	3
May 5, 1910	July 28, 1910	Laying 16-inch cast-iron pipe, \$0.50 per lin. ft.; rock excavation above regular grade, \$3.40 per cu. yd.	3,333.31	4
June 2, 1910	Dec. 3, 1910	Laying 60-inch cast-iron pipe \$3.82 per lin. ft.; lay- ing 12-inch and 16-inch cast-iron pipe for blow- offs, \$1.25 per lin. ft.; rock excavation above or below regular grade, \$8 per cu. yd.; earth exca- vation below regular grade, \$2 per cu. yd.; cham- bers for air valves \$50 each; chambers for blow-off and by-pass valves and for 36-inch valves \$60 each; concrete masonry, \$7 per cu. yd.	40,777.77	5
May 17, 1910	Dec. 22, 1910	36-inch hydraulic lift valves, \$1,272 each; 24-inch screw-lift valves, \$273 each; 16-inch screw-lift valves, \$168 each.	8,607 00	6
May 18, 1910	-	Straight pipe \$25.20 per ton of 2,000 pounds; special castings \$49, \$51 and \$54 per ton of 2,000 pounds.	4,860 00	7
Aug. 10, 1910	Dec. 8, 1910	Laying water pipes: 36-inch \$1.80, 30-inch \$1.50 per lin. ft.; rock excavation above regular grade \$6, below regular grade \$8 per cu. yd.; chambers for blow-off, by-pass and air valves \$45 each, for 30-inch and 36-inch valves \$75 each; spruce piles driven and cut off, \$0.18 per lin. ft.; spruce lum- ber in place for foundation, \$40 per M. feet B.M.; concrete masonry, \$6 per cu. yd.	13,086 10	8
July 21, 1910	Oct. 15, 1910	4-inch pipe \$26.70, 36-inch pipe \$24.70 per ton of 2,000 pounds; special castings \$47 per ton of 2,000 pounds.	3,932 64	9
Oct. 24, 1910	-	For whole work \$2,500,	-	10
Oct. 11, 1910	-	For whole work \$1,740,	-	11
Dec. 3, 1910	-	For whole work \$71,500,	-	12
Dec. 6, 1910	-	For whole work \$3,650,	-	13
June 18, 1909	May 25, 1910	-	2,693 34	14
July 16, 1909	Sept. 29, 1910	-	28,171 21	15

* Includes separate and combined bids for hydraulic and electric plant.

CONTRACTS MADE AND PENDING DURING THE

1. Num- ber of Con- tract.	2. WORK.	3. Num- ber of Bids.	AMOUNT OF BID.		6. Contractor.
			4. Next to Lowest.	5. Lowest.	
1	19-M Improvement of Lake Cochituate, Surface Water Drains in Framingham, Natick and Wayland.	7	\$31,298 00	\$30,981 00 ³	The Henry Spinach Contracting Co., Waterbury, Conn.
2	20-M 950 tons New River or Pocahontas coal; 250 tons for Arlington Pumping Station; 700 tons for Spot Pond Pumping Station.	3	\$4.55 and \$4.90 per ton.	\$4.20 ³ and \$4.85 per ton.	New England Coal and Coke Co., Boston.
3	21-M 4,000 tons Beaver Run coal for Chestnut Hill Pumping stations.	7	\$3.84 per ton.	\$3.83 ³ per ton.	Gorman-Leonard Coal Co., Worcester, Mass.
4	22-M Sale and purchase of electrical energy to be developed at Wachusett Dam.	3	-	\$5.30 ⁷ per M. kilowatt hours.	Connecticut River Transmission Co., Boston.
5	Special ¹ Order. 5 steel cylinders for tunnel shafts.	4	970 00	838 00 ³	Hodge ¹ Boiler Works, East Boston.
6	Special ¹ Order. Steel chambers for Venturi meter registers.	2	996 00	700 00 ³	Daniel Russell Boiler Works, Boston.
7	Special ¹ Order. Steelwork for chambers.	3	870 00	630 00 ³	James ¹ Russell Boiler Works, Boston.
8	Special ¹ Order. 1 ¹ Type D register and chart recorder for Venturi meter.	- ⁸	- ⁸	- ⁸	Builders Iron Foundry, Providence, R. I.
9	Special Order. Erecting boilers at Chestnut Hill Pumping Station.	2	660 00	600 00 ³	F. Knight & Son, Boston.
10	Special Order. 2 ¹ smoke flues at Chestnut Hill Pumping Station.	4	555 00	536 00 ³	B. F. Sturtevant Co., Boston.

¹ Contract completed.³ Contract based upon this bid.

YEAR 1910 — WATER WORKS — *Concluded.*

7. Date of Con- tract.	8. Date of Completion of Work.	9. Prices of Principal Items of Contracts made in 1910.	10. Value of Work done Dec. 31, 1910.	
June 22, 1910	-	Earth excavation: for open channel, \$1.10 per cu. yd., for covered drains, \$0.90 per cu. yd.; borrowed earth, \$0.30 per cu. yd.; rock excavation, \$10 per cu. yd.; concrete masonry, \$7 per cu. yd.; furnishing and laying vitrified clay pipe: 24-inch, \$1.10 per lin. ft., 18-inch, \$1 per lin. ft., 12-inch, \$0.50 per lin. ft.; spruce lumber in place, \$33 per M. feet B. M.; stone paving, \$1.50 per sq. yd.; gravel for slopes of open channel, \$1.50 per cu. yd.; manholes \$40 each; catch basins \$55 each.	\$30,674 52	1
July 25, 1910	-	\$4.20 per ton of 2,240 pounds delivered on cars at the Arlington Pumping Station; \$4.85 per ton of 2,240 pounds delivered in bins at the Spot Pond Pumping Station.	3,587 00	2
Aug. 18, 1910	-	\$3.83 per ton of 2,240 pounds delivered on cars at Chestnut Hill Pumping Stations.	5,756 00	3
Sept. 14, 1910	-	Estimated minimum amount of electrical energy available per year, 5,250,000 kilowatt hours,	-	4
June 30, 1910	Aug. 10, 1910	-	833 00	5
July 28, 1910	Oct. 29, 1910	Each complete chamber, \$175,	698 00	6
July 28, 1910	Oct. 27, 1910	Steelwork for chambers: for 36-inch valves, \$45 for each complete set; for 36-inch hydraulic valves, \$60 for each complete set.	690 00	7
Aug. 11, 1910	Oct. 12, 1910	-	525 00	8
Dec. -, 1910	-	-	-	9
Dec. 23, 1910	-	Flue from boiler to economizer, \$478; from economizer to chimney, \$58.	-	10
			\$628,733 87	

* Highest bid.

* Competitive bids were not received.

CONTRACTS MADE AND PENDING DURING THE YEAR 1910 — WATER WORKS
— *Concluded.*

Summary of Contracts.¹

	Value of Work done Dec. 31, 1910.
Wachusett Department, 2 contracts,	-
Distribution Department, 22 contracts,	\$555,105 80
302 contracts completed from 1896 to 1909, inclusive,	16,075,309 64
	<hr/> \$16,630,415 44
Deduct for work done on 11 Sudbury Reservoir contracts by the City of Boston, .	512,000 00
Total of 337 contracts,	<hr/> \$16,118,415 44

¹ In this summary, contracts charged to maintenance are excluded.

APPENDIX NO. 2.

TABLE NO. 1. — *Monthly Rainfall in Inches at Various Places on the Metropolitan Water Works, in 1910.*

PLACE.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.
Wachusett Watershed.													
Princeton,	5.43	4.64	1.39	3.44	3.28	4.23	1.82	3.45	2.86	1.36	4.23	2.21	38.34
Jefferson,	6.99	5.58	1.23	3.09	1.89	3.86	1.16	3.98	2.78	1.23	4.21	2.73	38.73
Sterling,	5.29	5.02	0.81	2.77	1.68	4.83	1.59	3.91	2.66	1.51	4.16	1.98	36.81
Boylston,	5.72	5.12	0.92	2.76	1.67	4.52	1.53	4.13	3.14	1.49	4.10	2.43	37.53
Sudbury Dam,	5.28	4.98	0.89	2.83	1.26	4.11	1.88	2.24	2.16	1.87	3.90	2.39	33.79
Framingham,	4.98	5.10	0.77	2.72	1.34	4.81	1.76	2.26	2.57	1.88	4.02	2.43	34.64
Ashland Dam,	5.45	4.95	0.91	2.61	1.16	5.06	2.37	2.86	2.58	1.71	4.04	2.64	36.34
Cordaville,	5.87	5.20	0.84	2.82	1.40	4.75	2.11	3.11	2.63	1.96	4.57	2.51	37.77
Lake Cochituate,	5.11	5.16	0.77	2.71	1.33	4.51	2.23	1.58	2.50	1.80	4.16	2.61	34.47
Chestnut Hill Reservoir,	6.11	5.69	1.16	3.57	2.03	5.36	1.93	1.18	2.65	1.69	4.77	2.91	39.05
Spot Pond,	4.80	4.84	1.02	2.68	1.32	4.59	1.47	1.19	2.38	1.13	3.71	2.28	31.41
Average of all,	5.55	5.17	0.97	2.91	1.67	4.60	1.80	2.72	2.63	1.60	4.17	2.47	36.26
Average, Wachusett watershed,	5.86	5.24	1.09	3.01	2.13	4.36	1.52	3.87	2.86	1.40	4.17	2.34	37.85
Average, Sudbury watershed,	5.39	5.06	0.85	2.75	1.29	4.68	2.03	2.62	2.49	1.86	4.13	2.49	35.64

TABLE NO. 2. — *Rainfall in Inches at Jefferson, Mass., in 1910.*

DAY OF MONTH.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1,	-	-	0.34	-	-	-	-	-	0.30	-	-	-
2,	-	-	-	-	-	-	-	0.55	-	-	‡	-
3,	-	‡	-	-	-	-	-	-	0.65	-	‡	-
4,	-	0.38‡	-	-	-	-	-	0.54	-	-	2.20	-
5,	‡	-	-	-	0.27‡	‡	-	-	‡	-	-	-
6,	‡	-	-	-	-	0.89	-	-	0.94	-	-	-
7,	1.99‡	-	0.72	-	-	-	-	-	-	0.20	-	-
8,	-	-	-	-	-	-	-	-	-	-	-	-
9,	-	0.38‡	-	-	0.36	‡	-	-	-	0.24	‡	-
10,	-	-	-	-	-	‡	-	‡	-	-	0.24	-
11,	-	‡	-	0.51	-	1.77	-	1.72	-	-	-	-
12,	-	1.79‡	-	-	-	0.80	-	-	-	-	0.06‡	-
13,	-	-	-	-	-	-	0.18	-	-	-	-	-
14,	‡	-	-	-	0.19	-	0.15	-	-	-	-	-
15,	1.29‡	-	-	-	-	-	-	0.27	-	0.07	-	0.35‡
16,	-	-	-	-	-	‡	-	0.29	-	-	-	-
17,	-	1.28‡	-	-	-	0.40	-	-	-	-	-	-
18,	0.51‡	-	-	0.89	0.31	-	-	-	-	-	-	-
19,	-	-	-	-	-	-	-	0.55	-	-	-	0.17
20,	-	-	0.17	-	-	-	-	-	-	-	-	0.04‡
21,	‡	0.54	-	-	0.11	-	-	-	0.24	-	-	0.35‡
22,	1.44	0.73‡	-	0.14	-	-	-	-	-	0.34	0.14	-
23,	-	0.08‡	-	-	-	-	-	-	-	-	-	-
24,	-	-	-	-	-	-	-	-	0.17	-	-	1.32
25,	0.74‡	-	-	1.00	0.27	-	-	-	-	0.13	0.17‡	-
26,	-	-	-	0.38	-	-	-	0.06	-	-	-	-
27,	0.14‡	‡	-	-	-	-	-	-	‡	0.25	-	-
28,	‡	0.40	-	-	-	-	0.33	-	0.48	-	‡	0.14
29,	0.88‡	-	-	0.17	-	-	-	-	-	-	1.40‡	0.36
30,	-	-	-	-	-	-	0.50	-	-	-	-	-
31,	-	-	-	-	0.38	-	-	-	-	-	-	-
Totals, . . .	6.99	5.58	1.23	3.09	1.89	3.86	1.16	3.98	2.78	1.23	4.21	2.73

Total for the year 38.73 inches.

‡ Snow.

‡ Rainfall included in that of following day.

‡ Rain and snow.

TABLE NO. 3. — *Rainfall in Inches at Framingham, Mass., in 1910.*

DAY OF MONTH.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1,	-	-	‡	-	‡	0.03	-	-	0.45	-	-	-
2,	-	-	0.20	-	0.03	-	-	-	-	-	‡	-
3,	0.02 [‡]	‡	-	-	‡	0.05	-	-	0.45	-	‡	-
4,	-	0.47 [‡]	-	0.02	‡	-	-	0.38	-	-	‡	-
5,	‡	-	-	-	0.23	‡	-	-	0.51	-	2.29	-
6,	‡	-	-	-	-	‡	-	-	0.72	-	-	‡
7,	1.84 [‡]	-	0.38	‡	-	1.07	-	-	-	0.13	-	0.37 [‡]
8,	-	-	-	0.25	‡	-	0.05	-	-	-	-	-
9,	-	0.23 [‡]	-	0.02	0.25	‡	-	-	-	0.47	‡	-
10,	-	-	-	-	0.01	‡	-	‡	-	-	0.31	-
11,	-	‡	-	0.30	-	‡	-	1.08	-	-	-	-
12,	-	1.64 [‡]	-	-	-	2.45	-	-	-	-	-	-
13,	‡	-	0.06 [‡]	-	-	-	0.19	-	-	-	-	-
14,	‡	-	-	-	-	-	-	-	-	‡	-	-
15,	0.93 [‡]	-	-	-	0.02	-	-	‡	-	0.20	-	0.03 [‡]
16,	-	‡	-	-	-	‡	0.23	0.08	-	-	-	-
17,	‡	0.92 [‡]	0.02 [‡]	‡	-	0.78	-	-	-	-	-	-
18,	0.29 [‡]	-	-	‡	0.31	0.33	-	‡	-	-	-	‡
19,	-	-	-	‡	-	-	-	0.57	‡	-	-	0.13
20,	-	-	0.07	0.75	‡	-	-	-	0.07	0.11	-	0.40 [‡]
21,	‡	0.49	-	‡	0.07	-	-	-	0.05	-	-	0.01 [‡]
22,	0.59	0.52 [‡]	-	0.44	‡	-	-	-	-	‡	-	-
23,	-	-	-	-	0.04	-	-	-	-	0.56	-	‡
24,	-	-	-	-	-	0.06	-	-	0.11	-	-	1.27
25,	0.48 [‡]	-	-	-	0.02	-	0.46	-	-	0.35	0.19	-
26,	‡	-	-	0.88	-	-	-	0.13	-	-	-	0.05 [‡]
27,	0.10 [‡]	‡	-	-	-	‡	‡	-	‡	‡	-	-
28,	‡	0.83	-	-	0.04	0.04	0.35	‡	0.21	0.06	‡	0.06 [‡]
29,	0.70 [‡]	-	-	‡	-	-	-	0.02	-	-	‡	-
30,	‡	-	-	0.06	‡	-	0.48	-	-	-	1.23 [‡]	0.11
31,	0.03 [‡]	-	0.04	-	0.32	-	-	-	-	-	-	-
Totals,	4.98	5.10 th	0.77	2.72	1.34	4.81	1.76	2.26	2.57	1.88	4.02	2.43

Total for the year 34.64 inches.

‡ Snow.

‡ Rainfall included in that of the following day.

‡ Rain and snow.

TABLE NO. 4. — *Rainfall in Inches at Chestnut Hill Reservoir in 1910.*

DATE.	Amount.	Duration.	DATE.	Amount.	Duration.
Jan. 3, .	.09 ¹	10.15 A.M. to 2.15 P.M.	May 2, .	.03	4.20 A.M. to 4.35 A.M.
Jan. 5, .	2.06 ²	8.00 A.M. to 1.00 P.M.	May 4, .	.09	4.30 P.M. to 2.30 P.M.
Jan. 7, .		4.20 A.M. to 7.30 A.M.	May 5, .		2.30 P.M. to 2.30 P.M.
Jan. 10, .	.05 ¹	12.45 A.M. to 1.00 P.M.	May 8, .	.20	11.10 A.M. to 12.50 P.M.
Jan. 14, .	1.43 ¹	2.15 A.M. to 1.15 A.M.	May 9, .		11.20 A.M. to 7.20 P.M.
Jan. 15, .		4.15 P.M. to 5.45 P.M.	May 15, .	.05	4.45 A.M. to 8.00 P.M.
Jan. 18, .	.40 ²	3.10 P.M. to 2.55 A.M.	May 18, .	.37	11.40 A.M. to 12.10 A.M.
Jan. 19, .	.73	10.40 P.M. to 10.30 P.M.	May 21, .	.21	11.30 A.M. to 9.00 A.M.
Jan. 21, .		7.55 P.M. to 10.15 P.M.	May 25, .	.08	11.40 A.M. to 11.50 P.M.
Jan. 22, .	.47 ²		May 26, .	.04	11.30 A.M. to 9.00 A.M.
Jan. 25, .	.05 ²		May 27, .		11.40 A.M. to 11.50 P.M.
Jan. 27, .			May 28, .	.03	11.30 A.M. to 11.40 A.M.
Jan. 28, .	.80		May 30, .	.88	11.40 A.M. to 9.30 P.M.
Jan. 29, .	.03 ¹		May 31, .	.05	
Jan. 30, .					
Total, .	6.11		Total, .	2.03	
Feb. 3, .	.60	7.00 P.M. to 2.45 A.M.	June 5, .	1.11	10.45 P.M. to 5.15 P.M.
Feb. 4, .		2.45 A.M. to 3.15 P.M.	June 7, .		10.40 P.M. to 10.30 P.M.
Feb. 9, .	.21	7.10 P.M. to 11.20 P.M.	June 9, .	3.40	10.00 A.M. to 2.10 P.M.
Feb. 11, .	1.52 ¹	9.00 P.M. to 9.10 A.M.	June 12, .		12.40 A.M. to 8.30 A.M.
Feb. 12, .		2.05 A.M. to 5.00 A.M.	June 16, .	.81	
Feb. 12, .	.03	2.45 A.M. to 11.35 P.M.	June 17, .	.04	
Feb. 17, .	.92 ²	9.05 A.M. to 8.30 P.M.	June 28, .		
Feb. 18, .		9.45 P.M. to 8.00 A.M.			
Feb. 21, .	.58		Total, .	5.36	
Feb. 22, .	.57 ²				
Feb. 27, .	1.01		July 8, .	.10	6.05 A.M. to 7.15 A.M.
Mar. 1, .			July 13, .	.11	1.15 P.M. to 2.15 P.M.
Total, .	5.69		July 16, .	.43	1.00 P.M. to 11.35 P.M.
Mar. 1, .	.29	8.00 A.M. to 4.30 P.M.	July 25, .	.51	5.00 P.M. to 8.45 P.M.
Mar. 2, .		9.00 P.M. to 10.30 A.M.	July 28, .	.28	2.35 A.M. to 5.40 A.M.
Mar. 6, .	.65	12.15 A.M. to 1.55 A.M.	July 30, .	.29	9.50 A.M. to 11.20 A.M.
Mar. 7, .		6.15 P.M. to 10.30 P.M.	July 30, .	.21	4.30 P.M. to 5.30 P.M.
Mar. 14, .	.08	7.55 P.M. to 10.00 P.M.			
Mar. 20, .	.04		Total, .	1.93	
Mar. 31, .	.10				
Total, .	1.16		Aug. 4, .	.13	12.30 P.M. to 8.30 P.M.
Apr. 4, .	.02	4.30 P.M. to 7.20 P.M.	Aug. 10, .	.19	6.15 P.M. to 8.00 A.M.
Apr. 7, .	.49	11.20 P.M. to 9.50 P.M.	Aug. 11, .		6.45 P.M. to 10.00 P.M.
Apr. 8, .		6.30 P.M. to 12.10 A.M.	Aug. 19, .	.53	12.50 A.M. to 9.25 A.M.
Apr. 11, .	.34	7.30 P.M. to 5.15 A.M.	Aug. 26, .	.24	10.35 A.M. to 10.45 A.M.
Apr. 12, .		8.00 P.M. to 5.00 A.M.			
Apr. 17, .	.90	2.40 A.M. to 11.30 A.M.	Total, .	1.18	
Apr. 19, .		5.35 A.M. to 10.45 P.M.			
Apr. 19, .	.05	11.15 P.M. to 8.00 A.M.	Sept. 1, .	.69	8.05 A.M. to 7.00 P.M.
Apr. 20, .			Sept. 3, .	.61	3.05 P.M. to 12.00 M.
Apr. 22, .	.58		Sept. 5, .	.41	12.50 A.M. to 12.10 A.M.
Apr. 26, .	1.11		Sept. 6, .		6.45 P.M. to 11.20 P.M.
Apr. 29, .			Sept. 21, .	.25	4.50 A.M. to 5.40 A.M.
Apr. 30, .	.08		Sept. 24, .	.04	5.50 P.M. to 12.15 A.M.
			Sept. 25, .		12.50 A.M. to 8.15 A.M.
Total, .	3.57		Sept. 28, .	.19	
			Total, .	2.65	

¹ Snow.² Rain and snow.

TABLE NO. 4. — *Rainfall in Inches at Chestnut Hill Reservoir in 1910 —*
Concluded.

DATE.	Amount.	Duration.	DATE.	Amount.	Duration.
Oct. 7, .	.21	10.15 A.M. to 9.00 P.M.	Dec. 6, .	.56 ¹	11.15 A.M. to 8.00 A.M.
Oct. 9, .	.31	5.40 P.M. to 9.20 P.M.	Dec. 7, .	.13	2.45 P.M. to 12.10 A.M.
Oct. 15, .	.11	4.00 P.M. to 8.35 P.M.	Dec. 15, .	.22	11.50 P.M. to 10.45 A.M.
Oct. 20, .	.06	9.00 A.M. to 4.30 P.M.	Dec. 18, .	.22 ¹	7.35 P.M. to 3.00 A.M.
Oct. 22, .	.69	2.30 P.M. to 7.50 A.M.	Dec. 19, .	1.52	6.15 A.M. to 11.40 P.M.
Oct. 23, .	.21	6.45 P.M. to 7.45 P.M.	Dec. 20, .	.05 ¹	4.30 P.M. to 12.35 A.M.
Oct. 25, .	.10	6.15 P.M. to 8.15 A.M.	Dec. 21, .	.09	4.50 P.M. to 10.00 P.M.
Oct. 27, .			Dec. 24, .	.12	3.40 P.M. to 8.00 A.M.
Oct. 28, .			Dec. 26, .		
Total, .	1.69		Dec. 27, .		
Nov. 2, .	.52	7.50 P.M. to 10.45 A.M.	Dec. 28, .		
Nov. 3, .	2.30	7.15 P.M. to 9.15 P.M.	Dec. 29, .		
Nov. 3, .			Dec. 30, .		
Nov. 4, .	.37	12.25 A.M. to 7.15 A.M.	Total, .	2.91	
Nov. 10, .	.03	7.00 P.M. to 8.00 P.M.			
Nov. 10, .	.11	7.15 A.M. to 5.15 P.M.			
Nov. 25, .	1.44 ²	12.20 A.M. to 4.55 A.M.			
Nov. 29, .					
Nov. 30, .					
Total, .	4.77				

Total for the year 39.05 inches.

¹ Snow.² Rain and snow.

TABLE NO. 5. — *Rainfall in Inches on the Wachusett Watershed,¹ 1897 to 1910.*

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.
1897,	3.46	2.86	4.01	2.32	5.06	5.11	8.65	3.47	1.93	0.94	7.62	6.41	51.84
1898,	6.65	3.30	2.27	4.43	3.38	3.11	3.01	10.61	3.15	7.21	6.81	3.99	57.92
1899,	2.93	5.12	6.75	1.94	1.33	5.51	3.82	3.20	4.11	2.72	1.94	2.03	41.40
1900,	4.56	8.69	6.19	2.76	4.34	3.59	3.20	3.18	3.46	2.90	6.44	3.15	52.46
1901,	1.75	1.13	5.82	9.64	7.02	1.51	5.66	4.58	3.10	3.70	2.43	9.36	55.70
1902,	2.72	4.91	5.27	4.36	2.24	2.51	3.87	3.95	4.26	6.36	0.93	7.20	48.53
1903,	2.85	4.42	6.58	3.10	1.24	10.37	3.43	3.88	2.93	4.43	2.36	3.99	49.58
1904,	4.02	2.66	3.40	7.45	2.99	3.44	3.84	3.68	5.30	1.78	1.62	2.88	43.06
1905,	6.10	1.72	3.95	2.60	0.83	4.88	5.39	3.09	6.90	1.81	2.52	3.79	43.58
1906,	2.59	2.74	5.17	3.12	6.58	5.95	5.52	4.34	2.61	3.95	2.25	4.26	49.08
1907,	2.84	2.32	1.82	2.65	2.96	3.54	3.03	1.26	9.50	5.68	5.74	4.40	45.74
1908,	3.40	4.82	2.77	2.62	5.34	1.29	3.85	6.49	1.04	2.13	1.05	3.03	37.83
1909,	3.52	6.10	4.38	5.71	2.65	3.03	4.25	3.59	3.90	1.70	1.68	3.99	44.50
1910,	5.86	5.24	1.09	3.01	2.13	4.36	1.52	3.87	2.86	1.40	4.17	2.34	37.85
Totals,	53.25	56.03	59.47	55.71	48.09	58.20	59.04	59.19	55.05	46.71	47.56	60.82	659.12
Average (14 years),	3.80	4.00	4.25	3.98	3.43	4.16	4.22	4.23	3.93	3.34	3.40	4.34	47.08

¹ Means of observations at four places, as follows: January, 1897, to December, 1900, Princeton, Jefferson, Sterling and South Clinton; January, 1901, to December, 1910, Princeton, Jefferson, Sterling and Boylston.

TABLE No. 6. — *Rainfall in Inches on the Sudbury Watershed,¹ 1875 to 1910.*

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.
1875,	2.42	3.15	3.74	3.23	3.56	6.24	3.57	5.53	3.43	4.85	4.83	0.94	45.49
1876,	1.83	4.21	7.43	4.20	2.76	2.04	9.13	1.72	4.62	2.24	5.76	3.62	49.56
1877,	3.22	0.74	8.36	3.43	3.70	2.43	2.95	3.68	0.32	8.62	5.80	0.87	44.02
1878,	5.63	5.97	4.69	5.79	0.96	3.88	2.97	6.94	1.29	6.42	7.02	6.37	57.93
1879,	2.48	3.56	5.14	4.72	1.58	3.79	3.93	6.51	1.88	0.81	2.68	4.34	41.42
1880,	3.57	3.98	3.31	3.11	1.84	2.14	6.27	4.01	1.60	3.74	1.78	2.83	38.18
1881,	5.56	4.65	5.73	2.00	3.51	5.39	2.35	1.36	2.62	2.95	4.09	3.96	44.17
1882,	5.95	4.55	2.65	1.82	5.07	1.66	1.77	1.67	8.74	2.07	1.15	2.30	39.40
1883,	2.81	3.87	1.78	1.84	4.19	2.40	2.68	0.73	1.52	5.60	1.81	3.55	32.78
1884,	5.09	6.54	4.72	4.41	3.47	3.44	3.67	4.65	0.85	2.48	2.65	5.17	47.14
1885,	4.71	3.87	1.07	3.60	3.48	2.87	1.43	7.18	1.43	5.09	6.09	2.72	43.54
1886,	6.36	6.28	3.61	2.22	3.00	1.47	3.27	4.10	2.90	3.24	4.64	4.97	46.06
1887,	5.20	4.78	4.90	4.27	1.16	2.65	3.76	5.28	1.32	2.83	2.67	3.88	42.70
1888,	4.15	3.68	6.02	2.43	4.82	2.54	1.41	6.22	8.59	4.99	7.22	5.40	57.47
1889,	5.37	1.65	2.37	3.41	2.95	2.80	8.94	4.18	4.60	4.25	6.29	3.14	49.95
1890,	2.53	3.51	7.73	2.64	5.21	2.03	2.46	3.87	6.00	10.51	1.20	5.31	53.00
1891,	7.02	5.23	6.48	3.91	2.01	3.77	3.39	4.73	2.38	3.83	3.09	3.68	49.52
1892,	5.85	3.14	4.06	0.83	5.58	2.76	4.23	4.44	2.84	1.17	5.80	1.13	41.83
1893,	2.92	8.20	3.67	3.60	6.61	2.38	2.57	5.41	1.74	4.07	2.20	4.86	48.23
1894,	4.09	3.91	1.43	3.42	4.24	1.15	3.26	2.03	2.63	5.34	3.43	4.81	39.74

¹ See note at bottom of page 174.

TABLE NO. 6. — *Rainfall in Inches on the Sudbury Watershed,¹ 1875 to 1910. — Concluded.*

YEAR.	January.	Febru- ary.	March.	April.	May.	June.	July.	August.	Septem- ber.	October.	Novem- ber.	Decem- ber.	Totals.
1895,	4.06	1.39	2.98	5.25	2.02	2.77	5.04	4.15	2.30	10.68	6.63	3.35	50.62
1896,	2.39	7.18	5.24	1.57	2.57	3.22	2.51	2.40	7.72	3.76	3.02	2.12	43.70
1897,	4.00	2.91	3.66	2.82	4.37	4.46	5.44	3.51	2.94	0.47	6.40	5.21	46.19
1898,	6.83	4.49	2.40	4.66	3.22	2.48	4.09	8.17	2.62	6.71	6.93	3.28	55.88
1899,	4.18	4.91	7.01	1.90	1.45	2.51	3.22	1.43	3.95	2.69	2.18	1.78	37.21
1900,	4.96	9.14	6.35	2.58	4.32	2.99	2.42	2.26	3.36	3.83	5.70	2.74	50.65
1901,	1.82	1.52	6.57	8.60	7.23	1.38	5.71	4.57	3.30	2.82	2.90	9.69	56.11
1902,	2.52	6.18	5.34	4.13	1.86	2.89	2.94	3.40	4.54	4.44	1.45	6.38	46.07
1903,	3.80	3.95	6.63	2.99	0.93	9.25	2.77	3.67	1.75	4.72	1.56	3.14	45.16
1904,	4.87	3.00	2.72	8.87	2.65	2.80	1.96	3.86	5.80	1.64	1.73	2.92	42.82
1905,	5.26	2.20	3.15	2.72	1.31	5.00	5.47	2.70	6.88	1.54	2.07	4.01	42.31
1906,	2.47	2.92	6.32	2.88	5.66	3.91	3.42	3.02	3.30	3.40	2.69	4.49	44.48
1907,	3.28	2.17	1.91	3.41	3.63	3.53	1.86	1.07	8.76	4.17	6.12	4.47	44.38
1908,	3.60	4.56	3.82	1.88	5.51	0.86	3.71	4.57	0.97	2.55	0.98	3.14	36.15
1909,	3.98	5.79	4.26	4.67	2.43	2.81	1.59	2.93	4.74	1.12	3.38	4.05	41.75
1910,	5.39	5.06	0.85	2.75	1.29	4.68	2.03	2.62	2.49	1.86	4.13	2.49	35.64
Totals,	150.17	152.84	158.10	126.56	120.15	113.37	128.19	138.57	126.72	141.40	138.07	137.11	1,631.25
Average (36 years),	4.17	4.25	4.39	3.51	3.34	3.15	3.56	3.85	3.52	3.93	3.83	3.81	45.31

¹ Means of observations at several places, as follows: January, 1875, to April, 1876, Lake Cochituate; April to June, 1876, Lake Cochituate, Westborough and Hopkinton; June to December, 1876, Lake Cochituate, Southborough, Marlborough, Westborough and Hopkinton; December, 1876, to January, 1883, Framingham, Southborough, Marlborough, Westborough and Hopkinton; January, 1883, to January, 1884, Framingham and Southborough; January, 1884, to January, 1890, Framingham and Westborough; January, 1890, to May, 1898, Framingham and Ashland Dam; June, 1898, to December, 1910, Framingham, Ashland Dam, Cordeville and Sudbury Dam.

TABLE No. 7. — *Yield of the Wachusett Watershed in Gallons per Day per Square Mile¹ from 1897 to 1910.*

MONTH.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	1905.	1906.	1907.	1908.	1909.	1910.	Mean for 14 Years, 1897-1910.
January,	796,000	1,563,000	2,092,000	796,000	519,000	1,676,000	1,265,000	659,000	1,266,000	1,132,000	1,458,000	1,738,000	592,000	1,846,000	1,243,000
February,	931,000	1,635,000	1,090,000	4,054,000	356,000	1,401,000	2,133,000	927,000	452,000	1,027,000	692,000	1,736,000	2,556,000	1,845,000	1,487,000
March,	2,760,000	3,083,000	2,776,000	3,722,000	2,718,000	3,992,000	3,423,000	3,008,000	3,004,000	1,860,000	1,697,000	2,192,000	2,129,000	2,640,000	2,786,000
April,	1,632,000	2,027,000	3,376,000	1,580,000	4,986,000	2,159,000	2,238,000	2,984,000	1,617,000	2,109,000	1,436,000	1,269,000	2,422,000	1,034,000	2,205,000
May,	1,163,000	1,390,000	862,000	1,382,000	2,729,000	1,031,000	569,000	1,498,000	445,000	1,533,000	965,000	1,415,000	1,212,000	608,000	1,200,000
June,	1,181,000	828,000	561,000	578,000	985,000	470,000	2,131,000	762,000	542,000	1,184,000	773,000	403,000	632,000	824,000	842,000
July,	1,442,000	333,000	354,000	217,000	477,000	292,000	624,000	497,000	365,000	728,000	335,000	220,000	233,000	62,000	441,000
August,	896,000	1,325,000	236,000	197,000	512,000	297,000	300,000	355,000	321,000	591,000	87,000	443,000	193,000	186,000	437,000
September,	380,000	676,000	250,000	127,000	320,000	241,000	375,000	1,494,000	1,228,000	277,000	810,000	88,000	208,000	145,000	401,000
October,	243,000	1,509,000	245,000	282,000	647,000	980,000	689,000	340,000	367,000	530,000	1,382,000	158,000	90,000	68,000	536,000
November,	1,283,000	2,170,000	430,000	875,000	517,000	635,000	634,000	343,000	440,000	749,000	2,540,000	125,000	363,000	354,000	819,000
December,	2,275,000	2,061,000	359,000	1,570,000	3,234,000	1,848,000	954,000	440,000	1,078,000	794,000	1,961,000	387,000	537,000	391,000	1,274,000
Average for year,	1,253,000	1,551,000	1,051,000	1,264,000	1,507,000	1,248,000	1,285,000	1,025,000	928,000	1,043,000	1,180,000	847,000	918,000	828,000	1,137,000
Average for driest six months,	886,000	1,013,000	312,000	377,900	576,000	471,000	626,000	413,000	541,000	613,000	725,000	238,000	270,000	201,000	578,000

¹ The area of the watershed used in making up these records included water surfaces amounting to 2.2 per cent. of the whole area from 1897 to 1902, inclusive, to 2.4 per cent. in 1903, to 3.6 per cent. in 1904, to 4.1 per cent. in 1905, to 5.1 per cent. in 1906, to 6.0 per cent. in 1907, to 7.0 per cent. in 1908, 1909 and 1910.

TABLE No. 8. — *Yield of the Sudbury Watershed in Gallons per Day per Square Mile¹ from 1875 to 1910.*

MONTH.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	1884.	1885.	1886.
January.
February.
March.
April.
May.
June.
July.
August.
September.
October.
November.
December.
Average for year.
Average for driest six months.

¹ The area of the Sudbury watershed used in making up these records included water surfaces amounting to 1.9 per cent. of the whole area from 1875 to 1878, inclusive, and was subsequently increased by the construction of storage reservoirs to 3.0 per cent. in 1879, 3.4 per cent. in 1885, 3.9 per cent. in 1894 and 6.5 per cent. in 1898. The watershed also contains extensive areas of swampy land, which, though covered with water at times, are not included in the above percentages of water surfaces.

TABLE No. 8. — *Yield of the Sudbury Watershed in Gallons per Day per Square Mile¹ from 1875 to 1910* — Continued.

MONTH.	1887.	1888.	1889.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.
January,	2,589,000	1,053,000	2,782,000	1,254,000	3,018,000	1,870,000	434,000	693,000	1,034,000	1,084,000	845,000	1,638,000
February,	2,829,000	1,950,000	1,196,000	1,529,000	3,486,000	943,000	1,542,000	991,000	541,000	2,676,000	1,067,000	3,022,000
March,	2,868,000	3,238,000	1,338,000	3,643,000	4,453,000	1,955,000	3,245,000	2,238,000	2,410,000	3,335,000	2,565,000	2,604,000
April,	2,620,000	2,645,000	1,410,000	1,875,000	2,397,000	871,000	2,125,000	1,640,000	2,515,000	1,494,000	1,515,000	1,829,000
May,	1,009,000	1,632,000	880,000	1,366,000	583,000	1,259,000	2,883,000	840,000	636,000	360,000	915,000	1,246,000
June,	413,000	421,000	653,000	568,000	413,000	428,000	440,000	419,000	174,000	399,000	962,000	530,000
July,	115,000	117,000	634,000	107,000	149,000	214,000	158,000	161,000	231,000	95,000	638,000	231,000
August,	214,000	379,000	1,432,000	132,000	163,000	280,000	181,000	208,000	229,000	57,000	591,000	1,107,000
September,	111,000	1,155,000	823,000	457,000	203,000	229,000	108,000	150,000	89,000	388,000	182,000	369,000
October,	190,000	1,999,000	1,230,000	2,272,000	210,000	126,000	222,000	374,000	1,379,000	592,000	94,000	1,160,000
November,	369,000	2,758,000	1,941,000	1,215,000	305,000	697,000	319,000	836,000	2,777,000	659,000	909,000	1,986,000
December,	643,000	3,043,000	2,241,000	996,000	544,000	435,000	796,000	716,000	1,782,000	657,000	1,584,000	1,799,000
Average for year,	1,154,000	1,697,000	1,383,000	1,285,000	1,315,000	781,000	1,037,000	770,000	1,152,000	1,019,000	991,000	1,450,000
Average for driest six months,	234,000	953,000	944,000	747,000	239,000	327,000	237,000	356,000	460,000	314,000	564,000	777,000

¹ The area of the Sudbury watershed used in making up these records included water surfaces amounting to 1.9 per cent. of the whole area from 1875 to 1878, inclusive, and was subsequently increased by the construction of storage reservoirs to 3.0 per cent. in 1879, 3.4 per cent. in 1885, 3.9 per cent. in 1894, and 6.5 per cent. in 1898. The watershed also contains extensive areas of swampy land, which, though covered with water at times are not included in the above percentages of water surfaces.

TABLE No. 8. — *Yield of the Sudbury Watershed in Gallons per Day per Square Mile¹ from 1875 to 1910 — Concluded.*

MONTH.	1899.	1900.	1901.	1902.	1903.	1904.	1905.	1906.	1907.	1908.	1909.	1910.	Mean for 36 Years, 1875-1910
January,	2,288,000	794,000	437,000	1,763,000	1,736,000	477,000	1,410,000	1,128,000	1,351,000	1,925,000	392,000	1,490,000	1,228,000
February,	1,381,000	3,800,000	300,000	1,674,000	2,279,000	882,000	330,000	1,041,000	624,000	1,536,000	2,286,000	1,849,000	1,764,000
March,	4,205,000	3,654,000	2,755,000	4,199,000	3,454,000	2,999,000	2,497,000	2,409,000	1,658,000	2,257,000	1,734,000	1,954,000	2,836,000
April,	2,521,000	1,350,000	4,204,000	1,885,000	2,261,000	3,294,000	1,643,000	1,949,000	1,607,000	1,117,000	1,721,000	667,000	2,005,000
May,	511,000	1,312,000	2,954,000	743,000	351,000	1,745,000	297,000	1,059,000	888,000	1,046,000	1,004,000	277,000	1,078,000
June,	66,000	316,000	753,000	303,000	1,987,000	419,000	467,000	707,000	761,000	194,000	239,000	516,000	515,000
July,	19,000	—18,000	306,000	66,000	445,000	62,000	177,000	398,000	9,000	—14,000	—121,000	—102,000	171,000
August,	—35,000	—34,000	424,000	135,000	307,000	170,000	114,000	180,000	—104,000	102,000	—45,000	—73,000	247,000
September,	94,000	65,000	305,000	178,000	130,000	397,000	1,246,000	19,000	541,000	—82,000	149,000	5,000	251,000
October,	115,000	186,000	412,000	506,000	492,000	191,000	158,000	301,000	741,000	47,000	—51,000	—51,000	454,000
November,	304,000	663,000	474,000	444,000	363,000	289,000	279,000	483,000	1,998,000	71,000	82,000	176,000	810,000
December,	220,000	1,096,000	2,695,000	1,779,000	582,000	269,000	887,000	659,000	2,032,000	136,000	263,000	221,000	1,019,000
Average for year,	973,000	1,082,000	1,342,000	1,140,000	1,190,000	931,000	795,000	860,000	1,010,000	694,000	625,000	570,000	1,027,000
Average for driest six months,	93,000	194,000	445,000	271,000	388,000	228,000	403,000	341,000	471,000	44,000	40,000	29,000	406,000

¹ The area of the Sudbury watershed used in making up these records included water surfaces amounting to 1.9 per cent. of the whole area from 1875 to 1878, inclusive, and was subsequently increased by the construction of storage reservoirs to 3.0 per cent. in 1879, 3.4 per cent. in 1885, 3.9 per cent. in 1894 and 6.5 per cent. in 1898. The watershed also contains extensive areas of swampy land — which, though covered with water at times, are not included in the above percentages of water surfaces.

NOTE. — The recorded yields, subsequent to the year 1897, are less accurate than those for previous years, due to unavoidable inaccuracies in the measurement of the quantity of water received from the Wachusett Reservoir.

TABLE No. 9. — *Wachusett System. — Statistics of Flow of Water, Storage and Rainfall in 1910.*

[Watershed above dam = 118.19 square miles].

MONTH.	Quantity of Water dis- charged through Wachusett Aqueduct (Gal- lons per Day). ¹	Quantity of Water wasted into River below Dam (Gallons per Day).	STORAGE. ²		Total Yield of Watershed (Gallons per Day).	Rainfall (Inches).	Rainfall collected (Inches).	Percent- age of Rainfall collected.
			Gain (Gallons per Day).	Loss (Gallons per Day).				
January,	83,061,000	1,558,000	132,184,000	—	218,197,000	5.86	3.293	56.2
February,	82,096,000	1,714,000	133,350,000	—	218,000,000	5.24	2.972	56.7
March,	77,174,000	1,710,000	232,103,000	—	311,953,000	1.09	4.709	432.8
April,	107,350,000	1,523,000	12,357,000	—	122,207,000	3.01	1.785	59.2
May,	93,697,000	5,045,000	—	27,810,000	71,910,000	2.13	1.085	50.9
June,	100,527,000	1,097,000	—	5,263,000	97,343,000	4.36	1.422	32.6
July,	131,900,000	2,023,000	—	127,574,000	7,310,000	1.52	0.110	7.2
August,	121,616,000	1,974,000	—	102,539,000	21,965,000	3.87	0.331	8.6
September,	111,493,000	1,943,000	—	97,210,000	17,107,000	2.86	0.250	8.7
October,	110,442,000	2,461,000	—	105,645,000	8,087,000	1.40	0.122	8.7
November,	97,823,000	2,280,000	—	59,020,000	41,883,000	4.17	0.612	14.7
December,	119,694,000	1,855,000	—	76,103,000	46,210,000	2.34	0.697	29.8
Total,	—	—	—	—	—	37.85	17.388	—
Average for year,	103,283,000	2,106,000	—	8,431,000	97,850,000	—	—	45.9

¹ Including 137,000 gallons per day drawn from aqueduct for the supply of the Westborough Insane Hospital.² Aggregate storage in Wachusett Reservoir and in ponds and mill reservoirs.

TABLE No. 10. — *Sudbury System. — Statistics of Flow of Water, Storage and Rainfall in 1910.*

[Watershed from 1875 to 1878 inclusive=77,764 square miles; in 1879 and 1880=78,238 square miles; and from 1881 to 1910 inclusive=75.2 square miles.]

MONTH.	Quantity of Water received through Wachusett Aqueduct (Gallons per Day). ¹	Quantity of Water discharged through Sudbury Aqueduct (Gallons per Day).	Quantity of Water discharged through Western Aqueduct (Gallons per Day).	Quantity of Water used by Framingham Works (Gallons per Day).	Quantity of Water diverted from Watershed by Sewers, etc. (Gallons per Day).	Quantity of Water wasted into River below Lowest Dam (Gallons per Day).	STORAGE.		Total Yield of Watershed (Gallons per Day).	Rain-fall (Inches).	Rain-fall collected (Inches).	Percentage of Rain-fall collected.
							Gain (Gallons per Day).	Loss (Gallons per Day).				
January, .	83,539,000	96,016,000	29,145,000	603,000	1,003,000	74,052,000	—	5,261,000	112,019,000	5.39	2.657	49.3
February, .	81,982,000	92,586,000	28,986,000	589,000	1,461,000	78,357,000	19,039,000	—	139,036,000	5.06	2.979	58.9
March, .	77,065,000	83,865,000	28,706,000	545,000	1,587,000	118,929,000	—	9,626,000	146,942,000	0.85	3.486	408.7
April, .	107,240,000	80,253,000	29,127,000	540,000	903,000	36,710,000	9,840,000	—	50,133,000	2.75	1.151	41.9
May, .	93,587,000	79,790,000	29,274,000	545,000	787,000	9,116,000	—	5,071,000	20,855,000	1.29	0.495	38.3
June, .	100,400,000	81,357,000	28,833,000	603,000	760,000	31,667,000	—	3,993,000	38,827,000	4.68	0.891	19.0
July, .	131,732,000	92,906,000	29,355,000	748,000	484,000	1,958,000	—	1,410,000	—7,690,000	2.03	—0.182	—9.0
August, .	121,458,000	87,845,000	29,419,000	606,000	468,000	1,500,000	—	3,848,000	—5,468,000	2.62	—0.130	—5.0
September, .	111,333,000	82,293,000	28,330,000	607,000	497,000	1,500,000	—	1,523,000	370,000	2.49	0.008	0.3
October, .	110,281,000	79,219,000	28,726,000	665,000	413,000	1,500,000	—	4,055,000	—3,813,000	1.86	—0.091	—4.9
November, .	97,670,000	71,250,000	28,710,000	670,000	580,000	9,573,000	143,000	—	13,257,000	4.13	0.304	7.4
December, .	119,542,000	92,942,000	29,052,000	790,000	697,000	11,558,000	1,145,000	—	16,642,000	2.49	0.395	15.8
Total, .	—	—	—	—	—	—	—	—	—	35.64	11.963	—
Av. for year, .	103,145,000	85,033,000	28,974,000	627,000	799,000	31,108,000	—	561,000	42,835,000	—	—	33.6

¹ Not including 137,000 gallons per day drawn through Wachusett Aqueduct for the supply of the Westborough Insane Hospital, which were not discharged into Sudbury Reservoir.

TABLE No. 11. — *Cochituate System. — Statistics of Flow of Water, Storage and Rainfall in 1910.*(Watershed of lake = 17.80 square miles.¹)

MONTH.	Quantity of Water discharged through Cochituate Aqueduct (Gallons per Day).	Quantity of Water diverted from Watershed by Sewers, etc. (Gallons per Day).	Quantity of Water wasted at Outlet of Lake (Gallons per Day).	STORAGE.		Total Yield of Watershed (Gallons per Day).	Rainfall collected (Inches).	Rainfall collected (Inches).	Percentage of Rainfall collected.
				Gain (Gallons per Day).	Loss (Gallons per Day).				
January.	-	958,000	-	26,926,000	-	27,884,000	5.11	2.80	54.7
February.	-	1,157,000	23,929,000	7,204,000	-	32,289,000	5.16	2.92	56.7
March.	-	516,000	31,716,000	-	4,487,000	27,745,000	0.77	2.78	361.1
April.	-	653,000	27,297,000	-	14,757,000	13,193,000	2.71	1.28	47.2
May.	-	429,000	6,226,000	281,000	-	6,935,000	1.33	0.70	52.3
June.	-	430,000	19,580,000	-	8,230,000	11,780,000	4.51	1.14	25.3
July.	-	68,000	4,539,000	-	1,713,000	2,894,000	2.23	0.29	13.0
August.	-	155,000	-	-	-	155,000	1.58	0.02	1.0
September.	-	140,000	-	1,020,000	-	1,160,000	2.50	0.11	4.5
October.	-	74,000	-	329,000	-	403,000	1.80	0.04	2.2
November.	-	133,000	-	4,223,000	-	4,357,000	4.16	0.42	10.2
December.	-	297,000	-	5,529,000	-	5,826,000	2.61	0.58	22.4
Total.	-	-	-	-	-	-	34.47	13.08	-
Average for year.	-	412,000	9,296,000	1,376,000	-	11,085,000	-	-	37.9

¹ Not including the watersheds of Dudley and Dug ponds.

TABLE NO. 12. — *Elevations of Water Surfaces of Reservoirs above Boston City Base at the Beginning of Each Month.*

DATE.	Chestnut Hill Reservoir. Ordinary High Water = 134.00.	Lake Cochituate. High Water = 144.36.	Farm Pond. High Water = 159.25.	Spot Pond. High Water = 163.00.	Weston Reservoir. High Water = 200.00.	FRAMINGHAM RESERVOIR.			Ashland Reservoir. Flash Boards 225.23.	Sudbury Reservoir. Flash Boards 259.97.	Hopkinton Reservoir. Flash Boards 305.00.	Whitehall Reservoir. Ordinary High Water = 337.91.	Wachusett Reservoir. Ordinary High Water = 395.00.
						No. 1. Flash Boards 169.27.	No. 2. Flash Boards 177.12.	No. 3. Flash Boards 186.50.					
Jan. 1, 1910, .	133.42	138.76	157.58	162.86	200.00	167.65	175.99	182.41	224.35	259.28	304.12	337.94	382.09
Feb. 1, 1910, .	134.03	142.69	158.21	163.22	200.08	168.05	176.34	183.54	224.11	259.19	302.97	336.22	385.14
Mar. 1, 1910, .	134.11	143.54	158.71	162.80	200.12	168.60	176.85	186.56	223.93	259.52	304.00	336.36	388.20
April 1, 1910, .	133.98	142.96	158.51	163.02	200.00	167.92	176.15	185.50	224.44	259.27	304.17	335.96	393.72
May 1, 1910, .	133.82	140.97	158.31	162.98	199.98	167.82	176.13	184.84	224.46	260.02	304.25	336.19	393.99
June 1, 1910, .	133.71	141.01	158.01	162.89	200.08	169.41	177.18	184.19	225.35	259.25	304.85	336.34	393.48
July 1, 1910, .	133.57	139.84	157.99	162.75	200.00	165.46	177.09	184.00	225.27	259.25	305.03	336.64	393.39
Aug. 1, 1910, .	134.38	139.58	157.63	162.57	200.02	169.75	176.50	184.24	225.10	259.31	304.61	336.35	390.64
Sept. 1, 1910, .	133.91	139.58	157.31	162.82	200.00	167.12	176.56	184.00	225.09	259.22	304.12	336.18	388.26
Oct. 1, 1910, .	133.84	139.73	157.22	162.81	199.97	167.60	177.00	182.94	225.05	259.24	304.05	336.19	386.05
Nov. 1, 1910, .	134.01	139.78	157.05	162.14	199.91	167.46	176.94	182.26	224.89	259.20	303.93	336.07	383.36
Dec. 1, 1910, .	133.85	140.39	157.25	161.37	200.05	167.68	175.99	182.76	224.40	259.22	304.11	336.04	381.66
Jan. 1, 1911, .	133.70	141.19	157.42	162.66	200.07	167.74	176.06	183.64	224.40	259.25	304.16	335.70	379.35

TABLE NO. 13. — *Sources from which and Periods during which Water has been drawn for the Supply of the Metropolitan Water District.**From Wachusett Reservoir into Sudbury Reservoir.*

7:00 A.M. Jan. 1, 1910	to	10:15 A.M. Jan. 7, 1910.
7:00 A.M. Jan. 8, 1910	"	9:30 A.M. Jan. 22, 1910.
7:05 A.M. Jan. 26, 1910	"	11:00 A.M. Jan. 26, 1910.
10:00 P.M. Jan. 26, 1910	"	10:10 A.M. Feb. 17, 1910.
11:10 A.M. Feb. 18, 1910	"	11:00 A.M. Feb. 21, 1910.
1:00 P.M. Feb. 24, 1910	"	10:00 A.M. Feb. 28, 1910.
2:00 P.M. Mar. 10, 1910	"	9:30 A.M. Apr. 13, 1910.
10:00 A.M. Apr. 14, 1910	"	7:15 A.M. Apr. 26, 1910.
3:00 P.M. Apr. 26, 1910	"	10:30 A.M. June 10, 1910.
12:00 N. June 11, 1910	"	10:30 A.M. July 12, 1910.
5:30 P.M. July 12, 1910	"	10:00 A.M. July 13, 1910.
3:00 P.M. July 13, 1910	"	6:00 A.M. July 23, 1910.
1:10 P.M. July 23, 1910	"	11:45 A.M. July 25, 1910.
5:10 P.M. July 25, 1910	"	6:00 A.M. July 26, 1910.
2:00 P.M. July 26, 1910	"	10:00 P.M. Dec. 4, 1910.
5:00 P.M. Dec. 5, 1910	"	10:00 P.M. Dec. 26, 1910.
5:00 P.M. Dec. 27, 1910	"	7:00 A.M. Jan. 1, 1911.

Total quantity, 37,698,200,000 gallons.

From Sudbury Reservoir through the Weston Aqueduct to the Weston Reservoir.

7:00 A.M. Jan. 1, 1910 to 7:00 A.M. Jan. 1, 1911.

Total quantity, 10,575,600,000 gallons.

From Framingham Reservoir No. 3 through Sudbury Aqueduct to Chestnut Hill Reservoir.

7:00 A.M. Jan. 1, 1910 to 7:00 A.M. Jan. 1, 1911.

Total quantity, 31,037,100,000 gallons.

TABLE No. 14. — *Average Daily Quantity of Water flowing through Aqueducts in 1910 by Months.*¹

MONTH.	Wachusett Aqueduct into Sudbury Reservoir (Gallons).	Weston Aqueduct into Metropolitan District (Gallons).	Sudbury Aqueduct into Chestnut Hill Reservoir (Gallons).
January,	83,539,000	29,145,000	96,016,000
February,	81,982,000	28,986,000	92,586,000
March,	77,065,000	28,706,000	83,865,000
April,	107,240,000	29,127,000	80,253,000
May,	93,587,000	29,274,000	79,790,000
June,	100,400,000	28,833,000	81,357,000
July,	131,732,000	29,355,000	92,906,000
August,	121,458,000	29,419,000	87,845,000
September,	111,333,000	28,330,000	82,293,000
October,	110,281,000	28,726,000	79,219,000
November,	97,670,000	28,710,000	71,250,000
December,	119,542,000	29,052,000	92,942,000
Average,	103,145,000	28,974,000	85,033,000

¹ Not including quantities wasted while cleaning and repairing aqueducts.

TABLE No. 15. — *Statement of Operation of Engines Nos. 1 and 2 at Chestnut Hill High-service Pumping Station for the Year 1910.*
 [3 per cent. allowed for slip.]

MONTH.	ENGINE No. 1.		ENGINE No. 2.		Total Amount pumped (Million Gallons).	Amount of Coal consumed (Pounds).	Amount of Ashes and Clinkers (Pounds).	Per Cent. of Ashes and Clinkers.	Quantity pumped per Pound of Coal, no Deduction for Heating or Lighting (Gallons).	AVERAGE LIFT (FEET).		Duty in Root-pounds no Deduction for Heating or Lighting.	Duty in Root-pounds on Basis of Plunger Displacement, no Deduction for Heating or Lighting.
	Total Pumping Time.	Hrs. Min.	Total Pumping Time.	Hrs. Min.						Engine No. 1.	Engine No. 2.		
January,	214 10	70 23	69 31	216 00	140.04	243,042	26,255	10.8	576.20	118.91	118.92	57,070,000	58,840,000
February,	235 35	83 63	40 18	117 35	123.81	207,654	24,118	11.6	596.23	119.47	120.74	59,543,000	61,390,000
March,	33 45	12 51	65 30	190 25	77.81	154,600	24,887	16.1	503.30	119.74	120.04	50,310,000	51,370,000
April,	151 15	53 94	61 08	173 45	115.02	169,697	25,630	15.1	677.80	121.20	120.79	68,310,000	70,430,000
May,	158 30	56 73	36 15	103 50	92.88	134,825	20,230	15.0	688.89	119.32	119.72	68,560,000	70,690,000
June,	301 45	110 75	-	-	110.75	147,694	19,885	13.5	749.86	118.91	-	74,280,000	76,590,000
July,	515 35	181.31	-	-	181.31	237,178	26,052	11.0	764.45	119.38	-	76,020,000	78,380,000
August,	359 25	122.76	-	-	122.76	185,480	18,840	10.2	661.85	119.17	-	65,700,000	67,740,000
September,	279 20	92.98	-	-	92.98	152,637	16,952	11.1	609.16	118.79	-	60,280,000	62,150,000
October,	142 50	48.28	36 90	110 50	85.18	150,175	15,625	10.4	567.20	118.97	119.33	56,280,000	58,030,000
November,	265 57	92.38	29 32	87 00	121.70	185,240	18,980	10.2	656.99	120.52	126.09	66,690,000	68,760,000
December,	-	-	113.47	337 00	113.47	199,302	22,800	11.4	567.91	-	119.46	56,510,000	58,270,000
Total,	2,658 07	925.50	452.21	1,336 25	1,377.71	2,168,024	260,254	-	-	-	-	-	-
Average,	-	-	-	-	-	-	-	12.0	635.47	119.41	120.19	63,340,000	65,310,000

TABLE No. 17. — Statement of Operation of Engine No. 4 at Chestnut Hill High-service Pumping Station for the Year 1910.

[2 per cent. allowed for slip.]

MONTH.	Total Pumping Time.	Hrs. Min.	Amount pumped, corrected for Slip (Million Gallons).	Amount of Coal consumed (Pounds).	Amount of Ashes and Clinkers (Pounds).	Per Cent. of Ashes and Clinkers.	Quantity pumped per Pound of Coal, no Deduction for Heating or Lighting (Gallons).	Average Lift (Feet).	Duty in Foot-pounds per 100 Pounds of Coal, no Deduction for Heating or Lighting.	Duty in Foot-pounds on Basis of Plunger Displacement, no Deduction for Heating or Lighting.	SUMMARY OF ENGINES Nos. 1, 2, 3 AND 4.	
											Total Amount pumped, corrected for Slip (Million Gallons).	Daily Average Amount pumped (Million Gallons).
January,		740 40	949.65	752,493	79,325	10.5	1,262.01	130.06	136,730,000	139,480,000	1,089.69	35.151
February,		668 50	858.05	661,802	62,363	9.4	1,296.54	131.06	141,550,000	144,400,000	981.86	35.067
March,		738 15	945.15	755,165	92,527	12.3	1,251.58	131.57	137,170,000	139,930,000	1,022.96	32.999
April,		620 20	793.77	641,673	80,725	12.6	1,237.03	130.05	134,010,000	136,700,000	990.25	33.008
May,		738 15	947.00	757,388	83,465	11.0	1,250.35	130.34	135,750,000	138,480,000	1,039.88	33.544
June,		718 15	921.21	741,409	87,960	11.9	1,242.51	130.53	135,100,000	137,820,000	1,031.96	34.399
July,		743 20	954.95	749,361	80,204	10.7	1,274.35	131.17	139,240,000	142,040,000	1,136.26	36.654
August,		741 05	951.44	731,995	73,630	10.1	1,299.79	130.98	141,820,000	144,670,000	1,074.20	34.652
September,		720 00	920.32	697,868	68,400	9.8	1,318.76	129.81	142,600,000	145,470,000	1,013.30	33.777
October,		742 15	951.58	720,695	71,405	9.9	1,320.36	130.77	143,830,000	146,720,000	1,036.76	33.444
November,		543 00	683.55	521,295	50,391	9.8	1,311.25	129.96	141,950,000	144,800,000	952.46	31.749
December,		741 35	948.03	736,733	80,220	10.9	1,266.80	130.43	139,810,000	142,620,000	1,061.50	34.242
Total,		8,455 50	10,824.70	8,467,877	911,215	-	-	-	-	-	12,431.08	-
Average,		-	-	-	-	10.8	1,278.33	130.58	139,050,000	141,840,000	-	34.058

TABLE No. 18. — Statement of Operation of Engines Nos. 5, 6 and 7, at Chestnut Hill Low-service Pumping Station for the Year 1910.

[2 per cent. allowed for slip.]

MONTH.	ENGINE No. 5.		ENGINE No. 6.		ENGINE No. 7.		Total Amount pumped (Million Gallons).	Daily Average Amount pumped (Million Gallons).	Total Amount of Coal consumed (Pounds).	Per Cent. of Ashes and Sulfur.	Quantity pumped per ton of Coal, no Deduction for Heating or Lighting (Gallons).	AVERAGE LIFT (FEET).			Duty in Foot-pounds per 100 Pounds of Coal, no Deduction for Heating or Lighting; corrected for Slip.	Duty in Foot-pounds per 100 Pounds of Coal, on Basis of Plunger Displacement, no Deduction for Heating or Lighting.
	Hrs. Min.	Total Pumping Time.	Hrs. Min.	Total Pumping Time.	Hrs. Min.	Total Pumping Time.						Engine No. 5.	Engine No. 6.	Engine No. 7.		
January,	698 15	768.47	726 15	800.19	232 55	312.04	1,880.70	60.668	692,495	10.3	2,715.83	49.61	49.76	35.31	107,010,000	109,200,000
February,	552 05	594.06	644 25	717.90	260 20	310.71	1,622.67	57.953	586,485	9.9	2,766.77	49.55	48.84	28.65	104,250,000	106,390,000
March,	479 30	524.50	616 55	711.89	326 10	346.07	1,582.46	51.047	585,570	10.4	2,702.43	50.35	49.44	25.25	100,070,000	102,120,000
April,	374 55	461.08	495 50	598.20	341 55	337.97	1,397.25	46.575	493,350	10.0	2,832.17	49.49	47.01	24.75	100,130,000	102,180,000
May,	500 40	578.46	550 10	595.84	256 05	254.01	1,428.31	46.075	578,230	10.0	2,470.14	56.64	57.45	29.46	107,290,000	109,490,000
June,	436 40	488.06	500 15	589.91	292 05	313.57	1,391.54	46.385	546,425	12.4	2,546.63	53.49	51.89	40.01	105,590,000	107,750,000
July,	589 05	652.01	737 30	812.37	170 40	185.79	1,650.17	53.231	671,380	12.1	2,457.88	56.64	56.79	52.68	115,200,000	117,560,000
August,	661 35	682.55	702 00	728.00	179 45	207.14	1,617.69	52.184	652,855	12.4	2,477.87	55.70	55.83	28.16	107,810,000	110,020,000
September,	550 20	623.62	566 05	651.21	143 45	147.35	1,422.18	47.406	542,220	10.5	2,622.88	51.60	51.30	21.36	105,590,000	107,750,000
October,	586 35	676.01	293 00	351.63	370 20	343.75	1,371.39	44.238	525,320	8.3	2,610.58	56.55	53.21	19.41	100,870,000	102,940,000
November,	30 40	29.93	720 00	810.34	439 10	363.42	1,203.69	40.123	500,845	8.9	2,403.32	61.43	61.57	19.06	97,560,000	99,560,000
December,	723 40	804.83	728 00	811.72	169 15	209.92	1,826.47	58.918	747,215	10.9	2,444.37	58.02	57.95	23.72	110,050,000	112,310,000
Total,	6,184 00	6,883.58	7,280 25	8,179.20	3,182 25	3,331.74	18,394.52	-	7,122,390	-	-	-	-	-	-	-
Average,	-	-	-	-	-	-	-	50.396	-	10.6	2,582.63	53.89	53.66	28.33	105,590,000	107,750,000

TABLE No. 19. — Statement of Operation of Engine No. 8 at Spot Pond Pumping Station for the Year 1910.

[2 per cent. allowed for slip.]

MONTH.	Total Pumping Time.		Amount pumped, corrected for Slip (Million Gallons).	Amount of Coal consumed (Pounds).	Amount of Ashes and Clinkers (Pounds).	Per Cent. of Ashes and Clinkers.	Quantity pumped per Pound of Coal, no Deduction for Heating or Lighting (Gallons).	Average Lift (Feet).	Duty in Root-pounds per 100 Pounds of Coal, no Deduction for Heating or Lighting; corrected for Slip.	Duty in Root-pounds on Basis of Plunger Displacement, no Deduction for Heating or Lighting.
	Hrs.	Min.								
January,	13	00	5.60	5,651	965	17.1	990.98	119.36	98,530,000	100,560,000
February,	-	-	-	-	-	-	-	-	-	-
March,	14	00	6.12	6,186	1,034	16.7	989.33	121.89	100,450,000	102,520,000
April,	14	00	6.11	6,100	1,120	18.4	1,001.64	121.03	100,980,000	103,060,000
May,	-	-	-	-	-	-	-	-	-	-
June,	29	00	12.20	12,317	2,206	17.9	990.50	124.83	103,000,000	105,120,000
July,	-	-	-	-	-	-	-	-	-	-
August,	15	30	7.02	6,840	975	14.3	1,026.32	120.60	103,100,000	105,220,000
September,	-	-	-	-	-	-	-	-	-	-
October,	63	45	27.70	28,036	2,110	7.5	988.02	119.73	98,540,000	100,600,000
November,	12	00	5.38	6,330	935	14.8	849.92	121.94	86,330,000	88,110,000
December,	-	-	-	-	-	-	-	-	-	-
Total,	161	15	70.13	71,460	9,345	-	-	-	-	-
Average,	-	-	-	-	-	13.1	981.39	121.15	99,040,000	101,080,000

TABLE No. 20. — *Statement of Operation of Engine No. 9 at Spot Pond Pumping Station for the Year 1910.*

[2 per cent. allowed for slip.]

MONTH.	Total Pumping Time.	Amount pumped, corrected for Slip (Million Gallons).	Amount of Coal consumed (Pounds).	Amount of Ashes and Clinkers (Pounds).	Per Cent. of Ashes and Clinkers.	Quantity pumped per Pound of Coal, no Deduction for Heating or Lighting (Gallons).	Average Lift (Feet).	Duty in Root-pounds per 100 Pounds of Coal, Heating or Lighting; corrected for Slip.	Duty in Root-pounds on Basis of Plunger Displacement, no Deduction for Heating or Lighting.	SUMMARY OF ENGINES Nos. 8 AND 9.	
										Total Amount pumped, corrected for Slip (Million Gallons).	Daily Average Amount pumped (Million Gallons).
January,	Hrs. Min. 259 45	215.47	183,576	22,943	12.2	1,142.62	130.39	124,110,000	126,630,000	221.07	7.131
February,	243 40	201.53	178,564	22,497	12.6	1,128.61	131.50	123,630,000	126,140,000	201.53	7.197
March,	254 15	208.93	186,279	23,485	12.6	1,121.60	131.25	122,630,000	125,120,000	215.05	6.937
April,	241 50	201.97	180,583	24,948	13.8	1,118.43	131.47	122,480,000	124,970,000	208.08	6.936
May,	273 20	228.67	224,027	32,899	14.7	1,020.73	132.43	112,600,000	114,890,000	228.67	7.376
June,	269 00	223.07	193,385	30,429	15.7	1,153.50	130.61	125,500,000	128,050,000	235.27	7.842
July,	359 30	209.52	247,560	34,927	14.1	1,209.89	131.58	132,610,000	135,300,000	299.52	9.662
August,	314 15	262.85	217,707	25,478	11.7	1,207.36	130.08	130,830,000	133,400,000	269.87	8.705
September,	271 40	227.97	189,177	21,557	11.4	1,205.06	129.96	130,460,000	133,110,000	227.97	7.599
October,	232 15	196.36	167,413	19,130	11.4	1,172.91	131.14	128,130,000	130,730,000	224.06	7.228
November,	237 00	197.50	173,953	19,842	11.4	1,135.36	132.86	125,650,000	128,200,000	202.88	6.763
December,	261 45	218.14	195,230	23,919	12.3	1,117.35	131.13	122,050,000	124,530,000	218.14	7.037
Total,	3,218 15	2,681.98	2,342,454	302,054	-	-	-	-	-	2,752.11	-
Average,	-	-	-	-	12.9	1,144.94	131.18	125,110,000	127,650,000	-	7.540

TABLE NO. 21. — (Meter Basis.) Average Daily Consumption of Water during the Year 1910, in the Cities and Towns supplied by the Metropolitan Water Works, including Boston, Somerville, Chelsea, Malden, Everett, Quincy, Medford, Melrose, Revere, Watertown, Arlington, Lexington, Milton, Stoneham, Winthrop, Swampscott, Belmont and Nahant. (For Consumption of Water in Whole Metropolitan Water District, see Table No. 24.)

MONTH.	Average Daily Consumption (Gallons).	Estimated Population.	Consumption per Inhabitant (Gallons).
January,	123,249,800	1,008,340	122
February,	123,890,200	1,010,350	123
March,	111,156,600	1,012,400	110
April,	106,842,500	1,014,610	105
May,	107,454,700	1,017,510	106
June,	109,031,100	1,020,330	107
July,	116,950,000	1,027,850	114
August,	111,973,800	1,028,120	109
September,	107,788,600	1,027,940	105
October,	106,881,000	1,027,500	104
November,	103,343,800	1,028,880	100
December,	117,015,000	1,030,960	114
For the year,	112,092,100	1,022,230	110

In addition to the above quantities, the United States Government Reservation on Peddocks Island was supplied with 31,191,300 gallons, equivalent to a daily average rate of 85,400 gallons, and a part of Saugus with 6,003,000 gallons, equivalent to a daily average rate of 16,500 gallons.

TABLE NO. 22. — (Meter Basis.) Average Daily Consumption of Water in Gallons, from the Low-service System in 1910.

MONTH.	SOUTHERN LOW SERVICE.	NORTHERN LOW SERVICE.	Total Low-service Consumption.
	Boston, excluding East Boston and Charlestown.	Portions of Charlestown, Somerville, Chelsea, Everett, Malden, Medford, East Boston and Arlington.	
January,	52,008,400	29,341,300	81,349,700
February,	52,117,200	29,847,800	81,965,000
March,	45,794,400	25,807,200	71,601,600
April,	43,047,100	24,374,300	67,421,400
May,	41,733,600	25,083,900	66,817,500
June,	41,526,700	25,628,700	67,155,400
July,	43,641,900	27,356,100	70,998,000
August,	42,837,100	25,988,400	68,825,500
September,	41,869,400	24,635,000	66,504,400
October,	41,724,200	24,242,100	65,966,300
November,	41,642,300	23,258,700	64,901,000
December,	48,406,200	27,016,300	75,422,500
For the year,	44,667,600	26,032,400	70,700,000

TABLE NO. 23. — (Meter Basis.) *Average Daily Consumption of Water, in Gallons, from the High-service and Extra High-service Systems in 1910.*

MONTH.	SOUTHERN HIGH SERVICE.	SOUTHERN EXTRA HIGH SERVICE.	NORTHERN HIGH SERVICE.	NORTHERN EXTRA HIGH SERVICE.
	Quincy, Watertown, and Portions of Boston, Belmont and Milton.	Portions of Boston and Milton.	Revere, Winthrop, Swampscott, Nahant, Stone- ham, Melrose, and Portions of Boston, Chelsea, Everett, Malden, Medford and Somerville.	Lexington and Portions of Arlington and Belmont.
January,	33,789,700	567,800	6,930,700	611,900
February,	33,602,900	612,500	7,057,100	652,700
March,	31,694,600	614,600	6,631,700	614,100
April,	31,378,500	623,800	6,716,500	702,300
May,	32,169,800	682,300	7,013,800	771,300
June,	32,816,400	709,000	7,587,300	763,000
July,	34,946,300	856,700	9,023,100	1,125,900
August,	32,922,500	794,100	8,476,000	955,700
September,	32,402,700	708,800	7,346,900	825,800
October,	32,276,200	705,100	7,124,500	808,900
November,	30,406,600	651,100	6,679,000	706,100
December,	33,330,900	640,100	6,883,400	738,100
For the year,	32,644,400 ¹	681,000	7,292,600 ²	774,100

In addition to the above ¹ the United States Government Reservation on Peddocks Island was supplied with a daily average rate of 85,400 gallons, and ² part of Saugus with a daily average rate of 16,500 gallons.

TABLE No. 24. — Average Daily Consumption of Water in Cities and Towns supplied from Metropolitan Works, as measured by Venturi Meters in 1910.

City or town,	MONTH.	BOSTON.			SOMERVILLE.			MALDEN.			CHELSEA.			EVERETT.			QUINCY.			MEDFORD.		
		674,400.			77,640.			44,730.			32,540.			33,710.			32,370.			23,330.		
		GALLONS.			GALLONS.			GALLONS.			GALLONS.			GALLONS.			GALLONS.			GALLONS.		
		Per Day.	Per Capita.		Per Day.	Per Capita.		Per Day.	Per Capita.		Per Day.	Per Capita.		Per Day.	Per Capita.		Per Day.	Per Capita.		Per Day.	Per Capita.	
January,	.	98,972,100	148	.	6,497,200	85	.	1,808,600	41	.	3,013,700	93	.	2,898,000	87	.	2,458,900	76	.	1,570,400	68	.
February,	.	99,226,600	149	.	6,451,100	84	.	1,823,000	41	.	3,113,000	96	.	2,942,700	88	.	2,440,800	75	.	1,583,700	69	.
March,	.	88,220,600	132	.	5,906,300	77	.	1,787,000	40	.	2,803,800	86	.	2,409,400	74	.	2,455,300	75	.	1,431,400	62	.
April,	.	84,165,200	126	.	5,734,600	74	.	1,750,800	39	.	2,619,900	81	.	2,405,600	72	.	2,501,000	77	.	1,366,900	59	.
May,	.	83,516,100	124	.	6,152,500	80	.	1,763,600	40	.	2,647,100	81	.	2,406,200	72	.	2,729,500	83	.	1,437,100	62	.
June,	.	84,070,500	125	.	6,202,300	80	.	1,901,400	43	.	2,726,900	84	.	2,515,000	75	.	2,979,500	91	.	1,422,400	61	.
July,	.	87,650,000	130	.	6,504,500	84	.	2,168,300	48	.	2,896,800	89	.	2,692,200	80	.	3,665,900	112	.	1,899,600	81	.
August,	.	84,596,800	125	.	6,211,500	80	.	2,133,800	48	.	2,888,900	89	.	2,585,200	77	.	3,521,000	107	.	1,542,100	66	.
September,	.	82,918,900	123	.	6,081,000	78	.	1,909,600	42	.	2,920,500	90	.	2,479,100	73	.	3,135,500	95	.	1,255,100	54	.
October,	.	82,298,800	121	.	6,256,400	80	.	1,894,000	42	.	2,775,200	85	.	2,473,000	73	.	3,055,500	92	.	1,257,100	53	.
November,	.	80,297,800	118	.	5,933,600	76	.	1,755,100	39	.	2,717,300	83	.	2,323,700	68	.	2,878,400	87	.	1,150,000	49	.
December,	.	92,777,700	136	.	6,355,300	81	.	1,786,900	39	.	2,907,200	89	.	2,733,900	80	.	2,843,200	85	.	1,155,000	49	.
For the year,	.	87,346,700	130	.	6,189,500	80	.	1,874,400	42	.	2,834,500	87	.	2,575,600	76	.	2,891,900	88	.	1,422,400	61	.

TABLE NO. 24. — *Average Daily Consumption of Water in Cities and Towns, etc.* — Continued.

City or town,	MONTH.	MELROSE.			REVERE.			WATERTOWN.			ARLINGTON.			MILTON.			WINTHROP.		
		15,790.			13,500.			12,360.			11,270.			7,970.			10,290.		
		GALLONS.	Per Capita.		GALLONS.	Per Capita.		GALLONS.	Per Capita.		GALLONS.	Per Capita.		GALLONS.	Per Capita.		GALLONS.	Per Day.	Per Capita.
Population supplied,		Per Day.			Per Day.			Per Day.			Per Day.			Per Day.			Per Day.		
January,		897,000	57		1,260,600	70		763,600	60		798,500	72		268,000	34		588,000		59
February,		929,100	59		1,307,100	72		780,600	61		809,500	73		288,400	36		592,800		59
March,		922,500	59		1,143,500	63		803,100	62		786,600	70		315,300	40		563,300		56
April,		971,100	62		1,112,300	61		788,800	61		839,200	75		339,200	43		598,300		59
May,		1,022,900	65		1,102,000	63		837,800	65		927,100	83		351,300	44		635,100		62
June,		1,043,000	66		1,309,300	71		832,500	64		944,400	84		330,900	42		745,500		73
July,		1,092,300	69		1,597,800	86		1,135,500	88		1,423,300	126		360,900	45		959,200		93
August,		1,141,800	72		1,711,300	92		976,000	75		1,184,000	105		302,000	38		808,500		78
September,		1,041,700	66		1,376,400	74		907,300	70		961,500	85		275,700	34		652,300		63
October,		1,055,700	67		1,275,500	68		961,800	74		911,900	80		329,300	41		569,000		54
November,		977,400	62		1,147,100	61		865,500	66		809,900	71		289,900	36		546,700		52
December,		968,500	61		1,348,800	71		905,300	69		846,600	74		257,600	32		529,100		50
For the year,		1,005,700	64		1,313,400	71		880,800	68		938,200	83		309,200	39		649,500		63

TABLE NO. 24. — *Average Daily Consumption of Water in Cities and Towns, etc.* — Concluded.

City or town,	STONEHAM.		BELMONT.		LEXINGTON.		NAHANT.		SWAMPSCOTT.		METROPOLITAN DISTRICT.	
	7,130.		5,600.		4,440. ¹		2,100. ¹		6,960. ¹		1,022,230.	
	GALLONS.		GALLONS.		GALLONS.		GALLONS.		GALLONS.		GALLONS.	
MONTH.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.
	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.
January,	621,300	88	229,600	42	255,300	58	64,200	54	284,800	46	123,249,800	122
February,	693,200	98	250,800	46	285,400	65	81,500	69	290,900	47	123,890,200	123
March,	653,600	92	282,500	51	258,200	59	62,300	53	291,900	47	111,156,600	110
April,	638,200	90	296,000	53	316,700	72	71,900	53	326,800	53	106,842,500	105
May,	638,200	97	336,300	60	343,700	78	132,500	61	385,700	59	107,454,700	106
June,	674,000	95	341,800	61	324,900	73	167,000	60	499,800	79	109,031,100	107
July,	803,600	113	511,700	91	528,400	119	305,900	62	754,100	77	116,950,000	114
August,	626,000	88	427,100	76	417,000	94	253,400	61	647,400	74	111,973,800	109
September,	586,900	82	331,900	59	379,200	85	127,000	54	449,000	54	107,788,600	105
October,	626,900	87	334,000	59	376,300	84	71,800	50	388,800	53	106,881,000	104
November,	633,500	88	313,600	55	318,200	71	59,400	49	326,700	52	103,343,800	100
December,	567,500	79	291,700	51	335,900	75	59,500	49	345,400	54	117,015,000	114
For the year,	650,800	91	329,500	59	345,500	78	121,700	58	412,800	59	112,092,100	110

¹ Allowance made for district not supplied.² Allowance for summer population.

TABLE NO. 25. — (Pump Basis.) Consumption of Water in the Metropolitan Water District, as constituted in the Year 1910, and a Small Section of the Town of Saugus, from 1893 to 1910.

[Gallons per day.]

MONTH.	1893.	1894.	1895.	1896.	1897.	1898.
January,	75,209,000	67,506,000	68,925,000	82,946,000	85,366,000	83,880,000
February,	71,900,000	68,944,000	80,375,000	87,021,000	83,967,000	87,475,000
March,	67,638,000	62,710,000	69,543,000	86,111,000	82,751,000	85,468,000
April,	62,309,000	57,715,000	62,909,000	77,529,000	79,914,000	76,574,000
May,	61,025,000	60,676,000	65,194,000	73,402,000	76,772,000	76,677,000
June,	63,374,000	68,329,000	69,905,000	77,639,000	77,952,000	83,463,000
July,	69,343,000	73,642,000	69,667,000	80,000,000	85,525,000	88,228,000
August,	66,983,000	67,995,000	72,233,000	78,537,000	84,103,000	87,558,000
September,	64,654,000	67,137,000	73,724,000	74,160,000	84,296,000	88,296,000
October,	63,770,000	62,735,000	67,028,000	71,762,000	79,551,000	81,770,000
November,	61,204,000	62,231,000	64,881,000	71,933,000	72,762,000	78,177,000
December,	66,700,000	65,108,000	70,443,000	79,449,000	76,594,000	86,355,000
Average,	66,165,000	65,382,000	69,499,000	78,360,000	80,793,000	83,651,000
Population,	723,153	743,354	763,557	786,385	809,213	832,042
Per capita,	91.5	88.0	91.0	99.7	99.8	100.5

MONTH.	1899.	1900.	1901.	1902.	1903.	1904.
January,	96,442,000	100,055,000	111,275,000	118,435,000	125,176,000	137,771,000
February,	103,454,000	98,945,000	117,497,000	117,268,000	122,728,000	143,222,000
March,	90,200,000	97,753,000	105,509,000	108,461,000	111,977,000	123,334,000
April,	86,491,000	89,497,000	93,317,000	103,153,000	107,179,000	108,688,000
May,	89,448,000	87,780,000	95,567,000	106,692,000	111,589,000	111,715,000
June,	97,691,000	98,581,000	103,420,000	110,002,000	105,590,000	111,209,000
July,	96,821,000	107,786,000	106,905,000	108,340,000	107,562,000	113,584,000
August,	92,072,000	102,717,000	102,815,000	107,045,000	103,570,000	112,836,000
September,	91,478,000	103,612,000	102,103,000	107,752,000	106,772,000	114,188,000
October,	89,580,000	98,358,000	103,389,000	106,560,000	103,602,000	108,290,000
November,	86,719,000	93,648,000	101,324,000	105,175,000	103,477,000	108,054,000
December,	85,840,000	97,844,000	113,268,000	125,434,000	114,721,000	125,119,000
Average,	92,111,000	98,059,000	104,645,000	110,345,000	110,277,000	118,114,000
Population,	854,870	877,698	892,740	907,780	922,820	937,860
Per capita,	107.8	111.7	117.2	121.6	119.5	125.9

TABLE No. 25. — (*Pump Basis.*) *Consumption of Water, etc.* — Concluded.

[Gallons per day.]

MONTH.	1905.	1906.	1907.	1908.	1909.	1910.
January,	130,878,000	126,093,000	137,730,000	132,376,000	133,275,000	127,568,000
February,	140,595,000	130,766,000	150,822,000	146,199,000	130,763,000	131,093,000
March,	120,879,000	123,570,000	134,202,000	128,884,000	126,842,000	117,078,000
April,	111,898,000	118,428,000	121,556,000	128,926,000	125,335,000	112,775,000
May,	115,804,000	122,404,000	123,502,000	131,040,000	123,305,000	112,073,000
June,	117,441,000	121,882,000	125,623,000	139,843,000	125,179,000	114,082,000
July,	124,769,000	118,726,000	128,779,000	138,232,000	126,765,000	122,743,000
August,	121,158,000	120,591,000	131,098,000	128,073,000	121,781,000	118,373,000
September,	120,103,000	121,685,000	124,751,000	129,972,000	118,043,000	112,434,000
October,	118,301,000	116,561,000	124,051,000	124,189,000	115,939,000	112,332,000
November,	116,693,000	113,746,000	119,627,000	117,119,000	111,664,000	107,528,000
December,	122,696,000	130,995,000	122,407,000	124,468,000	115,733,000	121,994,000
Average,	121,671,000	122,085,000	128,561,000	130,712,000	122,851,000	117,458,000
Population,	955,920	981,690	1,007,520	1,025,890	1,051,420	1,076,930
Per capita,	127.3	124.4	127.6	127.4	116.8	109.1

This table includes the water consumed in the cities and towns enumerated in Table No. 21, together with the water consumed in Newton and Hyde Park, which are included in the Metropolitan Water District, but have not been supplied from the Metropolitan Works. The populations for the years 1901 to 1909 were revised after the census of 1905 and of 1910 became available, and consequently the figures in the reports after 1904 and 1909 differ from those published in a corresponding table in the preceding annual reports.

TABLE No. 26. — *Chemical Examinations of Water from the Wachusett Reservoir, Clinton.*
[Parts per 100,000.]

Number.	Date of Collection.	APPEARANCE.			ODOR.		RESIDUE ON EVAPORATION.		AMMONIA.				NITROGEN AS		Oxygen consumed.	Hardness.
		Turbidity.	Sediment.	COLOR.					Free.	Total.	Dissolved.	Suspended.				
	1910.				Cold.	Hot.	Total.	Loss on Ignition.								
83029	Jan. 4	V. slight.	None.	18	Faintly vegetable.	Faintly vegetable.	3.25	1.60	.0024	.0110	.0102	.0008	.0010	.0000	.33	1.3
83298	Jan. 18	V. slight.	V. slight.	8	None.	V. faintly vegetable.	2.75	1.05	.0030	.0170	.0140	.0030	.0010	.0000	.22	1.3
83523	Feb. 1	V. slight.	Slight.	22	V. faintly vegetable and unpleasant.	Faintly vegetable and unpleasant.	2.75	1.20	.0046	.0246	.0224	.0022	.0020	.0000	.51	0.6
83784	Feb. 15	None.	V. slight.	15	V. faintly vegetable.	Faintly vegetable.	2.95	1.05	.0020	.0104	.0086	.0018	.0030	.0000	.37	1.3
84001	Mar. 3	V. slight.	V. slight.	22	V. faintly vegetable.	Faintly vegetable.	3.50	1.60	.0030	.0158	.0128	.0030	.0020	.0000	.35	1.3
84172	Mar. 15	V. slight.	V. slight.	20	Faintly vegetable.	Faintly vegetable and unpleasant.	3.20	1.10	.0014	.0130	.0096	.0034	.0020	.0000	.30	0.8
84566	Apr. 7	V. slight.	V. slight.	16	Faintly unpleasant.	Faintly unpleasant.	2.70	0.95	.0014	.0134	.0114	.0020	.0010	.0000	.37	1.3
84740	Apr. 19	V. slight.	Slight.	15	V. faintly vegetable.	Faintly vegetable.	3.00	1.05	.0014	.0106	.0100	.0006	.0010	.0000	.24	1.3
84980	May 3	V. slight.	V. slight.	15	V. faintly vegetable.	V. faintly vegetable.	2.85	0.95	.0008	.0126	.0104	.0022	.0010	.0001	.25	0.8
85184	May 17	V. slight.	V. slight.	12	V. faintly vegetable.	Faintly vegetable.	2.75	0.95	.0008	.0130	.0118	.0012	.0020	.0000	.24	0.8
85534	June 7	V. slight.	Slight.	16	V. faintly vegetable.	Faintly vegetable.	3.10	1.10	.0006	.0110	.0088	.0022	.0010	.0000	.24	0.8
85917	June 21	V. slight.	Slight.	13	V. faintly vegetable.	Faintly vegetable.	2.45	1.05	.0020	.0104	.0088	.0016	.0010	.0000	.28	0.5
86106	July 5	V. slight.	V. slight.	13	V. faintly vegetable and unpleasant.	Faintly vegetable and unpleasant.	3.05	1.00	.0010	.0102	.0092	.0010	.0020	.0000	.28	0.8
86786	Aug. 2	V. slight.	V. slight.	11	V. faintly vegetable.	V. faintly vegetable.	3.55	1.55	.0014	.0104	.0094	.0010	.0000	.0000	.22	1.0
87192	Aug. 23	V. slight.	V. slight.	11	Faintly vegetable.	Faintly vegetable.	8.05	1.10	.0014	.0150	.0134	.0016	.0010	.0000	.24	0.8
87471	Sept. 6	V. slight.	Slight.	10	None.	V. faintly vegetable.	2.70	1.15	.0008	.0094	.0084	.0010	.0000	.0000	.28	0.6
87798	Sept. 20	V. slight.	V. slight.	13	V. faintly vegetable.	Faintly vegetable.	2.75	1.00	.0010	.0138	.0126	.0012	.0010	.0000	.24	0.8
88116	Oct. 4	V. slight.	V. slight.	9	V. faintly vegetable.	Faintly vegetable.	2.85	1.00	.0018	.0112	.0106	.0006	.0000	.0000	.23	0.8
88442	Oct. 18	V. slight.	V. slight.	10	V. faintly vegetable.	Faintly vegetable.	2.80	1.00	.0032	.0124	.0112	.0012	.0000	.0000	.28	0.8
89021	Nov. 8	None.	V. slight.	10	V. faintly vegetable.	Faintly vegetable.	3.35	1.55	.0020	.0156	.0152	.0004	.0020	.0000	.22	0.8
89423	Nov. 21	None.	V. slight.	11	None.	None.	3.60	1.60	.0020	.0144	.0128	.0016	.0000	.0000	.17	0.8
89626	Dec. 6	V. slight.	V. slight.	11	V. faintly vegetable.	V. faintly vegetable.	2.55	1.15	.0014	.0094	.0080	.0014	.0010	.0000	.22	0.8
89905	Dec. 20	V. slight.	V. slight.	10	None.	V. faintly unpleasant.	2.20	1.00	.0020	.0148	.0138	.0010	.0010	.0000	.23	0.8
Av.	.....	.....	.....	14	.....	.....	2.94	1.17	.0018	.0130	.0115	.0016	.0010	.0000	.28	0.9

TABLE No. 27. — *Chemical Examinations of Water from Sudbury Reservoir.*

[Parts per 100,000.]

Number.	Date of Collection.	APPEARANCE.			ODOR.		RESIDUE ON EVAPORATION.		AMMONIA.				NITROGEN AS		Oxygen consumed.	Hardness.	
		Turbidity.	Sediment.	Color.					ALUMINOID.								
					Free.	Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.						
83042	1910. 4 Jan.	None.	None.	10	V. faintly vegetable.	Faintly vegetable.	2.80	1.00	.0020	.0142	.0116	.0026	.26	.0020	.0000	.27	1.3
83477	Jan. 31	V. slight.	V. slight.	12	None.	V. faintly vegetable.	3.15	1.45	.0016	.0112	.0100	.0012	.27	.0050	.0000	.22	1.3
83983	Mar. 2	V. slight.	V. slight.	15	V. faintly vegetable.	Faintly vegetable.	3.95	1.60	.0030	.0108	.0102	.0006	.28	.0060	.0000	.24	1.3
84485	Apr. 4	V. slight.	V. slight.	20	V. faintly vegetable.	Faintly vegetable.	3.70	1.75	.0016	.0156	.0108	.0048	.33	.0050	.0001	.34	1.3
84940	May 2	V. slight.	Slight.	15	Faintly vegetable.	Distinctly vegetable.	3.05	1.10	.0032	.0108	.0094	.0014	.29	.0040	.0001	.30	1.3
85494	June 6	V. slight.	Slight.	18	Faintly vegetable.	Faintly vegetable.	2.90	1.05	.0030	.0152	.0130	.0022	.29	.0010	.0001	.27	1.0
86091	July 5	V. slight.	V. slight.	14	Faintly vegetable.	Faintly vegetable.	2.55	1.10	.0034	.0166	.0130	.0036	.30	.0000	.0000	.27	1.0
86712	Aug. 1	V. slight.	Slight.	13	V. faintly vegetable.	V. faintly vegetable.	2.75	1.00	.0026	.0142	.0132	.0010	.27	.0000	.0000	.23	1.0
87483	Sept. 6	Slight.	Slight.	13	V. faintly vegetable.	Faintly vegetable.	3.50	1.15	.0006	.0096	.0078	.0018	.23	.0040	.0000	.28	1.0
88152	Oct. 5	None.	V. slight.	9	V. faintly vegetable.	Faintly vegetable.	2.60	0.90	.0010	.0132	.0108	.0024	.28	.0000	.0000	.18	0.8
88863	Nov. 2	V. slight.	V. slight.	11	V. faintly vegetable and unpleasant.	Faintly vegetable and unpleasant.	3.55	1.45	.0020	.0148	.0126	.0022	.27	.0010	.0000	.21	0.8
89588	Dec. 5	V. slight.	V. slight.	10	V. faintly vegetable.	V. faintly fishy.	2.30	1.00	.0006	.0114	.0104	.0010	.27	.0020	.0000	.18	0.8
Av.	.....	.....	.....	13	.....	.....	3.07	1.21	.0021	.0131	.0111	.0021	.28	.0025	.0000	.25	1.1

TABLE No. 28. — *Chemical Examinations of Water from Spot Pond, Stoneham.*

[Parts per 100,000.]

Number.	Date of Collection.	APPEARANCE.			ODOR.		RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	NITROGEN AS		Oxygen consumed.	Hardness.
		Turbidity.	Sediment.	COLOR.	Cold.	Hot.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
83114	1910. Jan. 10	None.	V. slight.	10	Faintly vegetable and unpleasant.	Faintly vegetable and unpleasant.	3.95	1.20	.0030	.0148	.0134	.0014	.38	.0010	.0001	.20	1.3
83472	Jan. 31	V. slight.	V. slight.	10	V. faintly unpleasant.	Faintly unpleasant.	2.70	1.00	.0020	.0134	.0126	.0008	.33	.0000	.0000	.16	1.3
83970	Mar. 2	V. slight.	V. slight.	10	None.	V. faintly vegetable.	3.50	1.10	.0040	.0162	.0116	.0046	.32	.0010	.0000	.19	1.3
84467	Apr. 4	V. slight.	Slight.	10	Faintly unpleasant and fishy.	Distinctly unpleasant and fishy.	2.90	1.30	.0022	.0156	.0114	.0042	.34	.0020	.0002	.21	1.3
84935	May 2	V. slight.	Slight, also scum.	9	Faintly unpleasant and fishy.	Distinctly unpleasant and fishy.	2.90	1.25	.0012	.0146	.0142	.0004	.35	.0010	.0000	.18	1.3
85487	June 6	V. slight.	V. slight.	10	V. faintly unpleasant.	Faintly unpleasant.	3.40	1.35	.0010	.0138	.0122	.0016	.34	.0000	.0001	.19	1.6
86083	July 5	V. slight.	V. slight.	10	V. faintly unpleasant.	V. faintly unpleasant.	4.45	1.70	.0010	.0162	.0138	.0024	-	.0000	.0000	.15	1.1
86707	Aug. 1	V. slight.	V. slight.	12	None.	V. faintly vegetable.	3.90	1.50	.0012	.0132	.0124	.0008	.31	.0000	.0000	.23	1.3
87499	Sept. 7	V. slight.	Slight.	11	V. faintly vegetable.	V. faintly vegetable.	3.45	1.10	.0008	.0136	.0108	.0028	.33	.0000	.0000	.22	1.1
88226	Oct. 10	V. slight.	V. slight.	5	Faintly unpleasant.	Distinctly unpleasant.	3.95	1.55	.0004	.0120	.0102	.0018	.33	.0000	.0000	.16	1.3
88967	Nov. 7	V. slight.	V. slight.	4	V. faintly vegetable.	V. faintly vegetable.	3.30	1.45	.0012	.0156	.0136	.0020	.31	.0000	.0000	.16	0.8
89613	Dec. 6	V. slight.	V. slight.	0	V. faintly vegetable.	V. faintly vegetable.	3.50	1.50	.0012	.0142	.0108	.0034	.32	.0000	.0000	.19	1.3
Av.	.....	.....	.....	8	.....	.....	3.49	1.33	.0016	.0144	.0123	.0022	.33	.0004	.0000	.19	1.3

TABLE No. 29. — *Chemical Examinations of Water from Lake Cochituate.*

[Parts per 100,000.]

Number.	Date of Collection.	APPEARANCE.		Odor.		RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.		NITROGEN AS		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	COLOR.	Cold.	Hot.	Total.	Loss on Ignition.	Free.	ALBUMINOID.			Nitrates.	Nitrites.			
										Total.	Dissolved.	Suspended.					
1910.																	
83074	Jan. 3	V. slight.	V. slight.	26	V. faintly vegetable.	Faintly vegetable.	6.05	1.85	.0032	.0214	.0172	.0042	.64	.0000	.0000	.33	2.2
83487	Jan. 31	V. slight.	Slight.	30	Distinctly unpleasant, decaying organisms.	Decidedly unpleasant, decaying organisms.	6.40	2.65	.0018	.0198	.0164	.0034	.63	.0030	.0000	.41	2.2
83955	Mar. 1	Slight.	Slight.	35	Faintly vegetable and unpleasant.	Faintly vegetable and unpleasant.	5.50	2.05	.0050	.0176	.0144	.0032	.50	.0040	.0000	.45	2.0
84491	Apr. 4	V. slight.	V. slight.	23	Distinctly unpleasant.	Distinctly unpleasant.	6.05	2.10	.0012	.0200	.0142	.0058	.58	.0030	.0001	.38	2.2
84974	May 2	V. slight.	Slight.	25	Distinctly unpleasant, decaying organisms.	Decidedly unpleasant, decaying organisms.	5.35	1.85	.0024	.0216	.0166	.0050	.60	.0030	.0001	.43	2.6
85499	June 6	V. slight.	Slight.	20	Faintly vegetable.	Distinctly vegetable.	6.15	2.20	.0020	.0238	.0164	.0074	.61	.0010	.0001	.37	2.2
86108	July 5	V. slight.	V. slight.	20	Faintly vegetable.	Faintly vegetable.	6.65	2.30	.0028	.0216	.0184	.0032	.67	.0000	.0001	.39	2.5
86719	Aug. 1	V. slight.	Slight.	42	V. faintly vegetable.	V. faintly vegetable.	5.35	1.80	.0008	.0172	.0168	.0004	.62	.0000	.0000	.35	2.2
87469	Sept. 6	V. slight.	V. slight.	15	V. faintly vegetable.	V. faintly vegetable.	5.95	1.80	.0008	.0204	.0184	.0020	.64	.0000	.0000	.34	2.5
88103	Oct. 3	V. slight.	V. slight.	12	Faintly unpleasant, decaying organisms.	Distinctly unpleasant, decaying organisms.	5.85	2.30	.0006	.0200	.0164	.0036	.66	.0010	.0000	.35	2.2
88997	Nov. 7	V. slight.	V. slight.	13	Faintly vegetable.	Faintly vegetable.	5.65	2.40	.0030	.0192	.0162	.0030	.63	.0000	.0000	.28	2.2
89585	Dec. 5	V. slight.	Slight.	16	V. faintly vegetable.	V. faintly vegetable and faintly unpleasant.	6.30	2.80	.0060	.0200	.0146	.0054	.60	.0010	.0002	.29	2.5
Av.	.....	.....	.....	23	.....	.....	5.94	2.18	.0025	.0202	.0163	.0039	.62	.0010	.0001	.36	2.3

TABLE No. 30. — *Chemical Examinations of Water from a Tap at the State House, Boston.*
[Parts per 100,000.]

Number.	Date of Collection.	APPEARANCE.			ODOR.		RESIDUE ON EVAPORATION.		AMMONIA.				NITROGEN AS		Oxygen Consumed.	Hardness.	
		Turbidity.	Sediment.	Color.	Cold.	Hot.	Total.	Loss on Ignition.	Free.	ALBUMINOID.			Chlorine.	Nitrates.			Nitrites.
										Total.	Dissolved.	Suspended.					
83008	1910. Jan. 3	None.	V. slight.	16	None.	V. faintly vegetable.	2.40	1.00	.0024	.0118	.0112	.0006	.26	.0030	.0000	.18	1.3
83475	Jan. 31	None.	V. slight.	15	V. faintly vegetable.	Faintly vegetable.	3.05	1.35	.0026	.0120	.0100	.0020	.26	.0060	.0000	.22	1.3
83927	Feb. 28	V. slight.	V. slight.	17	Faintly vegetable.	Faintly vegetable.	4.10	2.00	.0026	.0110	.0096	.0014	.27	.0050	.0000	.25	1.3
84468	Apr. 4	V. slight.	Slight.	17	Faintly vegetable.	Faintly vegetable.	3.70	1.60	.0016	.0124	.0100	.0024	.32	.0090	.0002	.25	1.3
84932	May 2	V. slight.	Slight.	20	Faintly vegetable.	Faintly vegetable.	3.20	1.10	.0014	.0116	.0112	.0004	.32	.0080	.0000	.24	1.3
85478	June 6	V. slight.	Slight.	17	V. faintly vegetable.	V. faintly vegetable.	3.30	1.20	.0012	.0152	.0118	.0034	.29	.0020	.0001	.27	1.3
86085	July 5	V. slight.	Slight.	12	Faintly vegetable.	Faintly vegetable.	3.25	1.25	.0010	.0144	.0112	.0032	.30	.0010	.0000	.19	0.8
86793	Aug. 4	V. slight.	Slight.	11	V. faintly vegetable.	V. faintly vegetable.	3.20	1.15	.0002	.0086	.0086	.0000	.29	.0000	.0001	.23	0.8
87477	Sept. 7	V. slight.	Slight.	12	Faintly vegetable.	Faintly vegetable.	2.95	1.00	.0002	.0108	.0098	.0010	.25	.0000	.0001	.23	0.8
88099	Oct. 4	V. slight.	V. slight.	10	V. faintly vegetable.	Faintly vegetable.	2.20	1.05	.0006	.0114	.0094	.0020	.26	.0010	.0000	.25	0.8
88886	Nov. 3	None.	V. slight.	10	V. faintly vegetable.	V. faintly vegetable.	2.70	1.00	.0010	.0114	.0102	.0012	.27	.0000	.0000	.21	1.3
89579	Dec. 5	V. slight.	V. slight.	10	None.	V. faintly vegetable.	2.55	1.15	.0008	.0108	.0092	.0016	.27	.0010	.0000	.16	1.3
Av.	.....	.....	.....	14	.....	.....	3.05	1.24	.0013	.0118	.0102	.0016	.28	.0030	.0000	.22	1.1

TABLE No. 31. — Averages of Examinations of Water from Various Parts of the Metropolitan Water Works in 1910.

[Parts per 100,000.]

LOCALITY.	Samples Collected.	COLOR.	RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	NITROGEN AS		Oxygen Consumed.	Hardness.
			Total.	Loss on Ignition.	Free.	ALBUMINOID.		Suspended.					
						Total.	Dissolved.						
										Nitrates.	Nitrites.		
Quinepozet River, Holden,	Semi-monthly,	41	3.72	1.48	.0019	.0157	.0140	.0018	.38	.0029	.0000	.49	0.8
Stillwater River, Sterling,	Semi-monthly,	36	3.72	1.52	.0017	.0139	.0119	.0016	.22	.0011	.0000	.43	0.9
Wachusett Reservoir, West Boylston,	Semi-monthly,	26	3.20	1.26	.0017	.0130	.0111	.0016	.26	.0015	.0000	.37	0.8
Wachusett Reservoir, Clinton, surface,	Semi-monthly,	12	2.94	1.17	.0018	.0130	.0115	.0016	.26	.0010	.0000	.28	0.9
Wachusett Reservoir, Clinton, bottom,	Semi-monthly,	14	2.91	1.21	.0025	.0109	.0095	.0015	.25	.0025	.0000	.28	0.9
Marlborough (Walker's Brook),	Monthly,	73	22.17	6.32	.4345	.0580	.0456	.0124	4.12	.0873	.0131	.89	7.0
Marlborough Brook filter-beds, effluent, ¹	Monthly,	12	17.38	-	.0215	.0113	-	-	2.28	.2767	.0008	.22	5.9
Wachusett Aqueduct, Southborough, ²	Monthly,	16	3.32	1.35	.0018	.0114	.0103	.0018	.26	.0028	.0000	.29	1.0
Sudbury Reservoir, surface,	Monthly,	13	3.07	1.21	.0021	.0131	.0111	.0021	.28	.0025	.0000	.25	1.1
Sudbury Reservoir, bottom,	Monthly,	14	3.26	1.31	.0038	.0124	.0108	.0018	.29	.0023	.0000	.24	1.1
Framingham Reservoir, No. 3, inlet,	Monthly,	13	3.08	1.24	.0019	.0119	.0104	.0015	.27	.0016	.0000	.25	1.0
Framingham Reservoir, No. 3, near dam,	Monthly,	14	3.31	1.25	.0028	.0144	.0117	.0027	.28	.0026	.0000	.26	1.2
Hopkinton Reservoir, inlet,	Monthly,	148	6.85	3.31	.0047	.0351	.0327	.0024	.48	.0011	.0000	1.49	1.6
Hopkinton Reservoir, surface,	Monthly,	48	3.88	1.65	.0019	.0177	.0158	.0019	.37	.0016	.0000	.59	1.2
Hopkinton Reservoir, bottom,	Monthly,	49	4.02	1.67	.0022	.0155	.0143	.0011	.38	.0025	.0001	.59	1.2
Ashland Reservoir, inlet,	Monthly,	100	5.37	2.42	.0029	.0284	.0252	.0033	.39	.0025	.0000	1.03	1.5
Ashland Reservoir, surface,	Monthly,	58	3.87	1.70	.0024	.0199	.0180	.0019	.33	.0013	.0000	.68	1.1
Ashland Reservoir, bottom,	Monthly,	54	3.84	1.63	.0030	.0196	.0165	.0031	.34	.0032	.0000	.63	1.2
Framingham Reservoir No. 2, inlet,	Monthly,	78	5.20	2.17	.0045	.0273	.0236	.0038	.42	.0030	.0000	.87	1.4
Framingham Reservoir No. 2, near dam, ²	Monthly,	68	4.60	2.00	.0041	.0237	.0211	.0027	.40	.0020	.0000	.78	1.2
Lake Cochituate, surface,	Monthly,	23	5.94	2.18	.0025	.0202	.0163	.0039	.62	.0010	.0001	.36	2.3
Lake Cochituate, bottom,	Monthly,	97	6.70	2.50	.0072	.0240	.0193	.0047	.60	.0013	.0002	.50	2.4
Dug Pond,	Monthly,	11	4.90	1.86	.0039	.0276	.0193	.0083	.67	.0022	.0001	.25	1.9
Weston Reservoir,	Monthly,	12	3.16	1.18	.0019	.0124	.0103	.0021	.28	.0032	.0000	.25	1.2
Terminal chamber, Sudbury Aqueduct,	Monthly,	14	3.35	1.28	.0025	.0129	.0112	.0019	.30	.0028	.0000	.24	1.1
Spot Pond,	Monthly,	8	3.49	1.33	.0016	.0144	.0123	.0022	.33	.0004	.0000	.19	1.3
Tap in Revere,	Monthly,	9	3.58	1.35	.0010	.0124	.0108	.0016	.32	.0008	.0000	.20	1.4
Tap at State House,	Monthly,	14	3.65	1.24	.0013	.0118	.0102	.0016	.28	.0030	.0000	.22	1.1
Tap in Quincy,	Monthly,	13	3.32	1.35	.0011	.0096	.0091	.0006	.28	.0033	.0000	.22	1.1

¹ Average of 6 samples.² Average of 11 samples.

TABLE NO. 32. — *Chemical Examinations of Water from a Faucet in Boston, from 1892 to 1910.*

[Parts per 100,000.]

YEAR.	COLOR.		RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	NITROGEN AS		Oxygen Consumed.	Hardness.
	Nessler Standard.	Platinum Standard.	Total.	Loss on Ignition.	Free.	ALBUMINOID.		Nitrates.		Nitrites.			
						Total.	Dissolved.				Suspended.		
1892, . . .	.37	37	4.70	1.67	.0007	.0168	.0138	.0030	.41	.0210	.0001	-	1.9
1893, . . .	.61	53	4.54	1.84	.0010	.0174	.0147	.0027	.38	.0143	.0001	.60	1.8
1894, . . .	.69	58	4.64	1.83	.0006	.0169	.0150	.0019	.41	.0106	.0001	.63	1.7
1895, . . .	.72	59	4.90	2.02	.0006	.0197	.0175	.0022	.40	.0171	.0001	.69	0.7
1896, . . .	.49	45	4.29	1.67	.0005	.0165	.0142	.0023	.37	.0155	.0001	.56	1.4
1897, . . .	.65	55	4.82	1.84	.0009	.0193	.0177	.0016	.40	.0137	.0001	.64	1.6
1898, . . .	.41	40	4.19	1.60	.0008	.0152	.0136	.0016	.29	.0097	.0001	.44	1.4
1899, . . .	.23	28	3.70	1.30	.0006	.0136	.0122	.0014	.24	.0137	.0001	.35	1.1
1900, . . .	.24	29	3.80	1.20	.0012	.0157	.0139	.0018	.25	.0076	.0001	.38	1.3
1901, . . .	.24	29	4.43	1.64	.0013	.0158	.0142	.0016	.30	.0173	.0001	.42	1.7
1902, . . .	.26	30	3.93	1.56	.0016	.0139	.0119	.0020	.29	.0092	.0000	.40	1.3
1903, . . .	.25	29	3.98	1.50	.0013	.0125	.0110	.0015	.30	.0142	.0001	.39	1.5
1904, . . .	-	23	3.93	1.59	.0023	.0139	.0121	.0018	.34	.0110	.0001	.37	1.5
1905, . . .	-	24	3.86	1.59	.0020	.0145	.0124	.0021	.35	.0083	.0001	.35	1.4
1906, . . .	-	24	3.86	1.39	.0018	.0159	.0134	.0025	.34	.0054	.0001	.36	1.3
1907, . . .	-	22	3.83	1.40	.0013	.0129	.0109	.0020	.33	.0068	.0001	.32	1.3
1908, . . .	-	19	3.50	1.35	.0011	.0115	.0092	.0024	.33	.0092	.0001	.26	1.2
1909, . . .	-	18	3.46	1.43	.0011	.0128	.0103	.0025	.28	.0034	.0000	.25	1.3
1910, . . .	-	14	3.05	1.24	.0013	.0118	.0102	.0016	.28	.0030	.0000	.22	1.1

Note relating to Chemical Examinations of Water, Tables Nos. 26-32.

The chemical examinations contained in the tables were made by the State Board of Health. Previous to the year 1904 colors were determined by the Nessler standard, but the corresponding values by the platinum standard are also given, for the purpose of comparison with colors determined in the laboratory of the Metropolitan Water and Sewerage Board, as given in subsequent tables. The odor recorded is taken in such a way that it is a much stronger odor than would be noticed in samples drawn directly from a tap or collected directly from a reservoir. The important samples are collected and examined semi-monthly or monthly.

TABLE No. 33. — *Microscopic Organisms in Water from Various Parts of the Metropolitan Water Works, from 1898 to 1910, inclusive.*
[Standard units per cubic centimeter; averages from weekly or biweekly observations.]

YEAR.	WACHUSETT RESERVOIR.		SUDBURY RESERVOIR.		LAKE COCHITUATE.		FRAMINGHAM RESERVOIR.		FRAMINGHAM RESERVOIR.		ASHLAND RESERVOIR.		HOPKINTON RESERVOIR.		WHITEHALL RESERVOIR.	
	Surface.	Bottom.	Surface.	Bottom.	Surface.	Bottom.	Surface.	Bottom.	No. 3.	Mid-depth.	Surface.	Bottom.	Surface.	Bottom.	Surface.	Bottom.
1898,	—	—	354	149	830	696	390	245	263	944	690	944	690	944	690	944
1899,	—	—	470	252	905	644	440	218	357	715	393	715	393	715	393	715
1900,	—	—	498	361	1,758	1,071	645	365	390	980	437	980	437	980	437	980
1901,	—	—	337	225	992	702	336	149	244	450	705	450	705	450	705	450
1902,	—	—	590	402	1,071	730	627	204	550	588	198	588	198	588	198	588
1903,	—	—	549	388	931	795	459	169	323	231	327	231	327	231	327	231
1904,	313	—	517	376	663	542	475	174	153	106	375	106	375	106	375	106
1905,	769	592	644	502	1,255	503	535	158	289	240	147	240	147	240	147	240
1906,	446	272	953	714	1,407	1,143	692	226	431	475	1,279	475	1,279	475	1,279	475
1907,	425	212	513	419	1,123	1,200	413	205	378	336	961	336	961	336	961	336
1908,	731	466	850	885	1,559	1,241	932	725	699	516	708	516	708	516	708	516
1909,	2,151	1,937	2,474	2,513	1,142	1,198	2,372	610	603	294	445	294	445	294	445	294
1910,	480	328	464	556	928	1,033	455	436	426	387	154	387	154	387	154	387
Mean,	759	635	709	596	1,120	884	675	299	393	482	525	482	525	482	525	482

NOTE. — A large growth of *Asterionella* originated in the Wachusett Reservoir in 1909, causing the large number of organisms in the water of Sudbury Reservoir and Framingham Reservoir No. 3, Weston and Chestnut Hill reservoirs, Spot Pond and in the water drawn from taps.

TABLE No. 33. — *Microscopic Organisms in Water, etc.* — Concluded.

[Standard units per cubic centimeter; averages from weekly or biweekly observations.]

YEAR.	WESTON RESERVOIR.		SPOT POND.		CHESTNUT HILL RESERVOIR.				TAPS.				
	Surface.	Inlet.	Surface.	SUDBURY AQUEDUCT.		COCHITUATE AQUEDUCT.		EFFLUENT GATE-HOUSE.		Southern Low Service.	Southern High Service.	Northern Low Service.	Northern High Service.
				Inlet.	No. 2.	Inlet.	No. 2.	No. 2.					
1898,	-	485	304	544	304	544	304	304	230	-	-	-	-
1899,	-	1,129	359	992	329	992	329	329	192	201	-	-	-
1900,	-	573	568	1,139	897	1,139	897	897	468	452	-	-	-
1901,	-	628	344	697	413	697	413	413	243	280	-	-	-
1902,	-	581	563	937	525	937	525	525	367	451	-	-	-
1903,	-	650	450	800	435	800	435	435	286	398	-	-	-
1904,	-	465	405	838	472	838	472	472	303	470	274	189	388
1905,	-	609	551	904	554	904	554	554	528	671	363	388	422
1906,	783	671	631	1,042	721	1,042	721	721	550	583	326	422	422
1907,	443	590	349	909	419	909	419	419	312	427	205	422	422
1908,	979	741	783	1,073	689	1,073	689	689	666	695	443	481	481
1909,	2,399	1,079	1,999	632	1,899	632	1,899	1,899	1,913	1,959	1,313	677	677
1910,	625	622	457	-	465	-	465	465	447	421	221	374	374
Mean,	1,046	679	597	881	625	881	625	625	500	584	449	422	422

NOTE. — A large growth of *Asterionella* originated in the Wachusett Reservoir in 1909, causing the large number of organisms in the water of Sudbury Reservoir and Framingham Reservoir No. 3, Weston and Chestnut Hill reservoirs, Spot Pond and in the water drawn from taps.

TABLE NO. 34. — *Number of Bacteria per Cubic Centimeter in Water from Various Parts of the Metropolitan Water Works, from 1898 to 1910, inclusive.*

[Averages of weekly determinations.]

YEAR.	CHESTNUT HILL RESERVOIR.			SOUTHERN SERVICE TAPS.	
	Sudbury Aqueduct Terminal Chamber.	Cochituate Aqueduct.	Effluent Gate-house No. 2.	Low Service, 244 Boylston Street.	High Service, 1 Ashburton Place.
1898,	207	145	111	96	—
1899,	224	104	217	117	123
1900,	248	113	256	188	181
1901,	225	149	169	162	168
1902,	203	168	121	164	246
1903,	76	120	96	126	243
1904,	347	172	220	176	355
1905,	495	396	489	231	442
1906,	231	145	246	154	261
1907,	147	246	118	130	176
1908,	162	138	137	136	148
1909,	198	229	119	150	195
1910,	216	—	180	178	213
Mean,	229	177	191	154	229

TABLE NO. 35. — *Colors of Water from Various Parts of the Metropolitan Water Works in 1910. (Means of Weekly Determinations.)*

[Platinum Standard.]

MONTH.	WACHUSETT RESERVOIR.						SUDBURY RESERVOIR.				FRAMINGHAM RESERVOIR.		LAKE COCHITUATE.			
	Surface.	Mid-depth.	Bottom.	Worcester Street Bridge.	Quinepoxet River.	Stillwater River.	Surface.	Mid-depth.	Bottom.	End of Open Channel.	No. 2.	No. 3.	Surface.	Mid-depth.	Bottom.	Influent Streams. ¹
January,	14	14	14	51	61	51	15	15	15	37	85	15	25	26	29	80
February,	21	16	16	54	61	53	18	19	19	20	89	23	47	29	48	102
March,	28	25	23	54	57	53	25	26	25	63	74	28	45	36	41	108
April,	18	20	21	42	54	48	23	23	23	22	95	24	31	32	34	111
May,	15	15	16	39	48	42	17	17	17	18	109	17	24	23	39	99
June,	16	16	17	34	71	45	17	17	17	24	112	17	22	25	47	114
July,	16	16	17	30	38	39	17	17	17	17	89	17	23	26	158	102
August,	16	17	18	18	31	27	16	17	17	17	72	16	22	25	153	55
September,	15	15	17	16	30	28	15	16	21	16	62	16	18	26	234	37
October,	14	14	15	15	34	26	14	14	14	14	50	14	17	21	273	35
November,	14	14	14	15	38	35	15	15	15	15	50	15	16	24	121	39
December,	12	12	13	16	34	30	13	13	13	14	47	13	20	21	22	40
Mean,	17	16	17	32	46	40	17	17	18	23	78	18	26	26	100	77

¹ The colors given in this column represent the combined colors of the waters of the four principal feeders. The color of each is determined monthly, and due weight is given, in combining the results, to the sizes of the streams.

TABLE NO. 35. — *Colors of Water, etc.* — Concluded.
[Platinum Standard.]

MONTH.	CHESTNUT HILL RESERVOIR.			SPOT POND.	FELLS RESERVOIR.	NORTHERN SERVICE.		SOUTHERN SERVICE.	
	Inlet (Sudbury Aqueduct).	Inlet (Cochituate Aqueduct).	Effluent Gate-house No. 2.	Mid-depth.	Effluent Gate-house.	Tap at Glenwood Yard, Medford (Low Service).	Tap at Fire Station, Hancock Street, Everett (High Service).	Tap at 244 Boylston Street, Boston (Low Service).	Tap at 1 Ashburton Place, Boston (High Service).
January,	15	-	15	12	12	14	12	15	15
February,	21	-	21	15	15	22	15	21	22
March,	26	-	26	16	16	26	16	27	27
April,	24	-	21	12	13	24	13	22	22
May,	18	-	17	9	10	17	10	17	17
June,	17	-	17	10	10	17	10	17	17
July,	17	-	17	10	10	17	10	17	17
August,	17	-	17	12	12	17	12	17	17
September,	15	-	15	12	12	16	12	16	17
October,	15	-	15	11	10	14	11	15	15
November,	14	-	14	12	12	14	12	14	14
December,	13	-	13	10	10	13	10	13	13
Mean,	18	-	17	12	12	18	12	18	18

TABLE NO. 36. — *Temperatures of Water from Various Parts of the Metropolitan Water Works in 1910.* (Means of Weekly Determinations.)

[The temperatures are taken at the same places and times as the samples for microscopical examination; the depth given for each reservoir is the depth from high water mark.]

[Degrees Fahrenheit.]

MONTH.	WACHUSETT RESERVOIR.			SUDBURY RESERVOIR (DEPTH AT PLACE OF OBSERVATION 54.5 FEET).				FRAMINGHAM RESERVOIR No. 3 (DEPTH AT PLACE OF OBSERVATION 20.5 FEET).			LAKE COCHITUATE (DEPTH AT PLACE OF OBSERVATION 62.0 FEET).		
	Surface.	Mid-depth.	Bottom.	Surface.	Mid-depth.	Bottom.	End of Open Channel.	Surface.	Mid-depth.	Bottom.	Surface.	Mid-depth.	Bottom.
January,	33.8	34.3	34.8	33.4	34.8	35.5	34.3	33.5	33.7	34.2	34.9	37.2	37.5
February,	34.0	35.0	35.5	33.3	36.1	37.4	35.0	34.1	34.7	34.3	33.4	35.5	36.1
March,	36.0	36.8	38.0	38.5	39.0	39.3	37.3	39.1	39.2	39.4	38.0	39.0	38.8
April,	45.0	43.8	44.3	50.9	49.6	48.8	46.5	52.1	51.9	51.5	49.5	47.0	45.0
May,	54.6	51.4	49.6	58.3	57.4	56.4	52.1	61.1	60.2	59.5	59.4	51.4	48.9
June,	65.5	55.8	51.8	66.8	62.9	61.3	56.4	69.5	69.0	66.7	66.6	53.0	47.1
July,	75.0	56.7	53.7	74.6	69.0	64.9	59.5	77.1	76.7	76.0	77.0	53.5	49.0
August,	71.5	57.0	53.8	71.9	68.3	65.2	57.6	73.3	73.0	72.9	72.8	53.8	44.8
September,	70.0	64.0	54.0	66.8	65.4	64.3	58.0	67.1	64.5	67.0	66.3	53.0	45.9
October,	60.0	59.5	55.8	60.1	62.0	59.0	57.1	58.0	57.7	57.9	59.8	55.5	46.0
November,	48.0	47.8	47.6	45.5	45.7	46.8	45.1	42.8	42.0	42.7	45.4	46.8	44.2
December,	34.8	35.5	36.0	34.5	35.1	36.3	35.0	34.9	35.3	35.0	37.3	37.3	39.5
Mean,	52.4	48.1	46.2	52.9	52.1	51.3	47.8	53.6	53.2	53.1	53.4	46.9	43.6

TABLE No. 36. — *Concluded.*

[Degrees Fahrenheit.]

MONTH.	CHESTNUT HILL RESERVOIR.	SPOT POND (DEPTH AT PLACE OF OBSERVATION 28.0 FEET).			NORTHERN SERVICE.		SOUTHERN SERVICE.	
	Effluent Gate- house No. 2.	Surface.	Mid-depth.	Bottom.	Tap at Glenwood Yard, Medford (Low Service).	Tap at Fire Station, Gloucester Street, Everett (High Service).	Tap at 244 Boylston Street, Boston (Low Service).	Tap at 1 Ashburton Place, Boston (High Service).
January,	37.0	34.8	34.9	35.6	39.3	38.0	39.8	39.2
February,	36.9	35.6	35.6	36.1	39.4	39.3	39.8	40.3
March,	41.5	38.9	39.4	39.5	41.7	41.3	43.9	43.6
April,	51.2	49.8	49.8	49.5	51.3	51.3	54.0	54.0
May,	58.1	57.8	57.7	56.8	57.6	57.7	59.4	59.6
June,	64.4	65.1	64.1	62.1	63.8	64.3	64.8	65.1
July,	77.6	75.3	74.6	66.5	73.4	73.6	75.9	76.4
August,	73.4	73.0	72.9	71.3	72.9	73.1	73.2	73.7
September,	67.6	68.1	67.3	67.3	67.3	67.0	67.4	68.3
October,	61.0	59.5	59.5	59.6	61.6	59.9	63.1	63.2
November,	44.2	45.5	45.6	45.9	51.4	47.2	47.8	48.8
December,	36.5	35.6	35.8	35.8	42.0	37.5	41.8	42.4
Mean,	54.1	53.3	53.7	52.2	55.1	54.2	55.9	56.2

TABLE No. 37. — *Temperatures of the Air at Three Stations on the Metropolitan Water Works in 1910.*

[Degrees Farenheit.]

MONTH.	CHESTNUT HILL RESERVOIR.			FRAMINGHAM.			CLINTON.		
	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.
January,	56.0	—6.0	29.3	55.0	—12.0	27.8	51.0	—12.0	26.5
February,	59.0	—5.0	28.7	56.0	—7.0	27.2	53.0	—8.0	23.4
March,	78.0	14.0	41.8	77.0	12.0	41.7	77.0	12.0	39.2
April,	79.0	27.0	52.6	77.0	25.0	52.4	77.0	26.0	50.7
May,	89.0	34.0	58.3	87.0	32.0	57.6	82.0	36.0	56.2
June,	92.0	37.0	64.9	90.0	35.0	64.6	85.0	37.0	63.3
July,	95.0	52.0	74.4	96.0	50.0	73.2	92.0	52.0	71.7
August,	91.0	44.0	69.4	87.0	41.0	67.5	82.0	46.0	66.6
September,	84.0	37.0	63.5	82.0	32.0	62.7	80.0	40.0	60.3
October,	87.0	22.0	55.5	84.0	20.0	54.4	80.0	24.0	52.2
November,	62.0	19.0	39.3	60.0	15.0	38.3	58.0	19.0	37.9
December,	54.0	1.0	26.3	51.0	—2.0	24.6	49.0	2.0	23.8
Average,	—	—	50.3	—	—	49.3	—	—	47.7

TABLE NO. 38. — *Table showing Length of Main Lines of Water Pipes and Connections owned and operated by Metropolitan Water and Sewerage Board, and Number of Valves set in Same, Dec. 31, 1910.*

	DIAMETER OF PIPES IN INCHES.													Total.
	60	48	42	36	30	24	20	16	14	12	10	8	6	
Total length owned and operated Jan. 1, 1910 (feet),	14,418	184,531	8,075	46,915	26,927	59,004	57,272	59,082	26	26,028	3,751	1,575	929	488,533
Gate valves in same,	-	49	-	44	28	42	39	70	1	82	17	13	19	404
Air valves in same,	9	111	3	35	5	26	34	30	-	10	1	-	-	264
Length laid or relaid during 1910 (feet),	12,234	1,549	-	3,470	754	355	98	8,516	-	313	12	286	4	27,591
Gate valves in same,	2	-	-	2	1	7	3	1	-	11	-	2	1	30
Air valves in same,	13	-	-	3	1	3	-	3	-	-	-	-	-	23
Length abandoned during 1910 (feet),	-	3,419	-	38	-	2	59	16	-	276	16	36	20	3,882
Gate valves in same,	-	-	-	-	-	-	1	-	-	2	-	1	1	5
Air valves in same,	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Length owned and operated Jan. 1, 1911 (feet),	26,652	182,661	8,075	50,347	27,681	59,357	57,311	67,582	26	26,065	3,747	1,825	913	512,242 ²
Gate valves in same,	2	49	-	46	29	49	41	71	1	91	17	14	19	429
Air valves in same,	22	111	3	38	6	29	34	33	-	10	1	-	-	287

¹ Includes 17,583 feet of 60-inch, 3,357 feet of 36-inch and 730 feet of 30-inch pipe laid but not yet used.

² 97.02 miles.

This table does not include 10 feet of 48-inch and 292 feet of 36-inch pipe laid as temporary line in Harvard Square, Cambridge.

TABLE No. 39. — *Statement of Cast-iron Hydrant, Blow-off and Drain Pipes, owned and operated by Metropolitan Water and Sewerage Board, Dec. 31, 1910.*

	DIAMETER OF PIPES IN INCHES.								Total.
	24	20	16	12	10	8	6	4	
Total length in use Dec. 31, 1910 (feet),	352	293	2,371	4,773	173	327	2,828	1,439	12,556
Total valves in use Dec. 31, 1910,	—	—	22	87	1	2	63	44	219

TABLE No. 40. — *Length of Water Pipes, Four Inches in Diameter and Larger, in the Several Cities and Towns supplied by the Metropolitan Water Works, Dec. 31, 1910.*

By Whom Owned.	INCHES.														TOTAL.						
	60	48	42	40	36	30	28	24	20	18	16	14	12	10	8	7	6	5	4	Feet.	Miles.
Metropolitan Water Works,	26,652	182,661	8,075	—	50,347	27,681	—	59,357	57,311	—	67,582	26	26,065	3,747	1,825	—	—	913	—	512,242	97.02
Boston,	—	39,175	16,813	23,104	44,804	98,937	244	77,482	95,017	—	217,108	8,037	1,258,713	196,103	655,574	—	—	1,254,094	64,125	4,041,293	765.40
Somerville,	—	—	—	—	—	—	—	—	3,596	367	3,537	9,152	83,032	51,181	99,560	—	—	202,574	20,498	472,382	89.47
Malden,	—	—	—	—	—	—	—	—	—	—	—	—	64,834	27,595	27,603	—	—	212,787	60,741	452,712	85.74
Chelsea,	—	—	—	—	—	—	—	—	—	—	5,176	806	4,974	39,820	27,610	—	—	135,936	7,949	221,465	41.94
Everett,	—	—	—	—	—	—	—	2,484	2,900	—	—	—	5,570	39,502	22,031	—	—	137,236	30,600	243,362	46.09
Quincy,	—	2,233	—	—	—	—	—	—	—	—	23,232	806	26,654	37,534	98,561	994	—	267,547	948	564,967	107.01
Medford,	—	6,775	9,598	—	—	—	—	—	673	—	6,775	9,598	26,452	37,738	78,161	—	—	107,116	106,848	299,454	56.71
Melrose,	—	5,223	2,920	—	—	—	—	—	—	—	5,223	2,920	22,986	19,016	24,249	—	—	130,405	53,506	258,305	48.92
Revere,	—	22,650	5,700	—	—	—	—	—	—	—	22,650	5,700	19,280	14,550	17,503	—	—	56,779	75,522	211,984	40.15
Watertown,	—	—	—	—	—	—	—	—	—	—	400	11,877	5,959	4,644	19,861	—	—	120,206	12,666	175,813	33.26
Arlington,	—	—	—	—	—	—	—	—	—	—	31,804	21,621	32,742	32,742	94,517	—	—	22,602	203,286	38.50	
Milton,	—	—	—	—	—	—	—	—	—	—	103	44	22,548	20,935	50,860	—	—	122,999	15,982	233,471	44.22
Winthrop,	—	—	—	—	—	—	—	—	—	—	—	—	4,049	23,297	30,339	—	—	62,531	156,151	29,571	29.57
Stoneham,	—	—	—	—	—	—	—	—	—	—	—	—	4,525	4,725	3,775	—	—	35,935	62,531	156,151	29.57
Belmont,	—	—	—	—	—	—	—	—	—	—	—	—	1,771	14,324	19,617	—	—	94,189	13,438	120,652	22.85
Lexington,	—	—	—	—	—	—	—	—	—	—	—	—	9,000	2,669	9,360	—	—	78,585	235	114,532	21.69
Nahant,	—	—	—	—	—	—	—	—	—	—	—	—	150	11,550	4,800	—	—	79,002	35,693	135,724	25.70
Swampscott,	—	—	—	—	—	—	—	—	—	—	—	—	7,390	14,041	9,738	—	—	36,800	55,200	108,500	20.55
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	57,893	9,025	98,087	18.58
Total feet,	26,652	221,836	24,888	23,104	95,151	126,618	244	139,323	162,176	367	354,019	48,160	1,625,756	584,592	1,283,769	994	3,225,513	948	680,102	8,624,212	—
Total miles,	5.05	42.01	4.71	4.38	18.01	23.98	0.05	26.39	30.71	0.07	67.05	9.12	307.91	110.72	243.14	0.19	610.89	0.18	128.81	—	1,633.37

¹ Includes small portion of Saugus.

TABLE NO. 41. — *Number of Service Pipes, Meters and Fire Hydrants in the Several Cities and Towns supplied by the Metropolitan Water Works, Dec. 31, 1910, and the Number of Services and Meters installed during the Year 1910.*

CITY OR TOWN.	Services.	Meters.	Fire Hydrants.	Services Installed.	Meters Installed.
Boston,	93,780	13,720	8,406	1,134	6,615
Somerville,	12,149	5,810	1,065	149	728
Malden,	7,440	7,163	440	161	185
Chelsea,	4,790	3,082	346	105	884
Everett,	5,380	1,186	528	62	354
Quincy,	7,307	2,634	808	493	602
Medford,	4,550	4,296	545	149	1,704
Melrose,	3,583	3,777	320	79	270
Revere, ¹	3,454	891	183	188	295
Watertown,	2,042	2,070	341	69	97
Arlington,	2,050	1,288	398	83	167
Milton,	1,454	1,454	356	74	74
Winthrop,	2,487	2,386	207	167	873
Stoneham,	1,467	635	112	21	207
Belmont,	909	909	177	63	63
Lexington,	836	475	138	57	113
Nahant,	532	227	81	20	48
Swampscott,	1,478	1,465	142	82	110
Total,	156,688	58,468	14,593	3,156	13,389

¹ Includes small portion of Saugus.

TABLE No. 42. — Average Maximum and Minimum Monthly Heights, in Feet, above Boston City Base, to which Water rose at Different Stations on the Metropolitan Water Works in 1910.

1910. MONTH.	LOW SERVICE.										SOUTHERN HIGH SERVICE.								
	BOSTON ENGINE HOUSE, BULFINCH STREET.		ALISTON ENGINE HOUSE, HARVARD STREET.		MEDFORD, MYSTIC RESERVOIR.		MEDFORD CITY HALL ANNEX, HIGH STREET.		SOMERVILLE CITY HALL ANNEX, WALNUT STREET.		MALDEN WATER WORKS SHOP, GREEN STREET.		CHELSEA COURT HOUSE.		BOSTON METRO- POLITAN WATER WORKS OFFICE, 1 ASHBURTON PLACE.		WATERTOWN WATER WORKS OFFICE, MAIN STREET.		
	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.
January,	136	126	180	168	167	163	167	163	168	162	165	161	163	155	249	235	263	259	
February,	134	124	180	170	167	164	167	163	167	162	164	161	163	155	249	236	263	256	
March,	136	129	180	171	168	164	168	163	168	163	165	162	165	157	249	237	263	257	
April,	141	126	178	170	168	165	168	163	167	163	165	161	166	158	249	236	263	257	
May,	151	129	188	179	180	171	180	171	176	168	169	164	170	160	248	235	263	255	
June,	149	129	181	172	168	164	168	163	167	161	165	161	166	156	248	235	263	255	
July,	142	128	183	176	167	163	167	162	167	163	165	162	166	156	249	236	262	247	
August,	144	128	184	175	167	164	166	162	168	162	166	161	166	156	249	237	262	248	
September,	143	130	182	172	168	164	168	162	167	162	166	160	166	157	249	237	263	253	
October,	150	129	188	181	167	163	167	162	167	162	165	161	165	157	249	237	263	255	
November,	152	129	195	192	166	162	166	161	168	163	165	161	165	157	250	237	263	258	
December,	134	125	184	175	167	164	167	162	168	163	165	161	163	154	248	235	261	255	
Averages,	143	128	184	175	168	164	168	163	168	163	165	161	165	157	249	236	263	255	

TABLE NO. 42. — *Average Maximum and Minimum Monthly Heights, in Feet, above Boston City Base, etc. — Concluded.*

MONTH.	SOUTHERN HIGH-SERVICE — Concluded.										NORTHERN HIGH-SERVICE.										NORTHERN EXTRA HIGH-SERVICE.	
	BELMONT WATER WORKS SHOP, WAYERLEY STREET.		MILTON WATER WORKS OFFICE, ADAMS STREET.		FORBES HILL TOWER, QUINCY.		QUINCY WATER WORKS SHOP.		SOMERVILLE PUMPING STATION, CEDAR STREET.		MALDEN CITY HALL.		REVERE WATER WORKS OFFICE, BROADWAY.		LYNN ENGINE HOUSE, UNION SQUARE.		WINTHROP TOWN HALL, HERMAN STREET.		LEXINGTON TOWN HALL, MARCHESNETTS AVENUE.		Maximum.	Minimum.
	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.		
January, .	263	254	247	239	238	231	237	221	270	255	271	264	268	257	266	257	197	175	382	368		
February, .	263	254	246	238	237	230	236	219	270	257	269	263	268	258	266	257	198	176	386	371		
March, .	263	252	246	236	237	230	237	219	270	256	272	266	269	258	267	258	200	178	379	365		
April, .	262	250	247	236	238	228	237	217	269	253	272	265	269	258	267	258	200	170	387	371		
May, .	262	249	246	234	236	226	235	215	270	250	271	263	268	254	267	252	206	177	387	368		
June, .	262	249	245	235	235	224	234	211	268	249	268	260	265	252	263	250	210	187	385	365		
July, .	262	238	246	231	234	219	232	200	268	240	268	258	261	244	254	227	203	178	380	351		
August, .	262	241	245	234	235	222	232	204	267	249	267	259	260	246	255	235	193	176	386	362		
September, .	263	251	246	235	236	225	235	209	268	250	268	261	266	258	264	256	187	174	386	371		
October, .	263	249	247	233	239	226	237	210	269	249	269	263	265	257	264	257	192	178	387	368		
November, .	263	251	248	233	238	230	238	211	270	253	271	266	267	259	266	259	194	182	386	369		
December, .	262	253	245	234	238	230	236	212	269	252	270	266	266	259	264	258	198	188	386	369		
Averages, .	263	249	246	235	237	227	236	212	269	251	270	263	266	255	264	252	198	178	385	367		

APPENDIX No. 3.

WATER WORKS STATISTICS FOR THE YEAR 1910.

The Metropolitan Water Works supply the Metropolitan Water District, which includes the following cities and towns:—

CITY OR TOWN.	Population, Census of 1910.	Estimated Population, July 1, 1910.
Boston,	670,585	674,400
Somerville,	77,236	77,640
Malden,	44,404	44,730
Chelsea,	32,452	32,540
Newton, ¹	39,806	39,960
Everett,	33,484	33,710
Quincy,	32,642	32,870
Medford,	23,150	23,330
Hyde Park, ¹	15,507	15,560
Melrose,	15,715	15,790
Revere,	18,219	18,500
Watertown,	12,875	12,960
Arlington,	11,187	11,270
Milton,	7,924	7,970
Winthrop,	10,132	10,290
Stoneham,	7,090	7,130
Swampscott,	6,204	6,260
Lexington,	4,918	4,940
Belmont,	5,542	5,600
Nahant,	1,184	1,200
1 Total population of Metropolitan Water District,	1,070,256	1,076,650
Saugus, ²	280	280

¹ No water supplied to these places during the year from Metropolitan Water Works.

² Only a small portion of Saugus is supplied with water.

Mode of Supply.

26 per cent. by gravity.

74 per cent. by pumping.

*Pumping.**Chestnut Hill High-service Station: —*

Builders of pumping machinery, Holly Manufacturing Company, Quintard Iron Works and E. P. Allis Company.

Description of coal used: — Bituminous: Beaver Run, Nan-ty-glo, and Vulcan. Anthracite: buckwheat. Price per gross ton in bins: bituminous \$3.96 to \$4.09, buckwheat \$2.75 to \$2.80. Average price per gross ton \$3.70. Per cent. ashes, 11.0.

Chestnut Hill Low-service Station: —

Builders of pumping machinery, Holly Manufacturing Company.

Description of coal used: — Bituminous: Vulcan, Beaver Run. Anthracite: buckwheat. Price per gross ton in bins: bituminous \$3.79 to \$4.01, buckwheat \$2.58 to \$2.62. Average price per gross ton \$3.46. Per cent. ashes, 10.6.

Spot Pond Station: —

Builders of pumping machinery, Geo. F. Blake Manufacturing Company and Holly Manufacturing Company.

Description of coal used: — Bituminous: Davis, Georges Creek and New River. Anthracite: screenings. Price per gross ton in bins: bituminous \$4.60 to \$4.88, screenings \$2.50. Average price per gross ton \$4.29. Per cent. ashes, 12.9.

	CHESTNUT HILL HIGH-SERVICE STATION.		
	Engines Nos. 1 and 2.	Engine No. 3.	Engine No. 4.
Daily pumping capacity (gallons),	16,000,000	20,000,000	30,000,000
Coal consumed for year (pounds),	2,168,024	247,119	8,467,877
Cost of pumping, figured on pumping station expenses, . . .	\$8,114.83	\$1,014.59	\$33,239.02
Total pumpage for year, corrected for slip (million gallons), .	1,377.71	228.67	10,824.70
Average dynamic head (feet),	119.67	129.88	130.58
Gallons pumped per pound of coal,	635.47	925.34	1,278.33
Duty on basis of plunger displacement,	65,310,000	104,710,000	141,840,000
Cost per million gallons raised to reservoir,	\$5.890	\$4.437	\$3.071
Cost per million gallons raised one foot, . . . . .	.0492	.0342	.0235

	CHESTNUT HILL LOW-SERVICE STATION.	SPOT POND STATION.
	Engines Nos. 5, 6 and 7.	Engines Nos. 8 and 9.
Daily pumping capacity (gallons),	105,000,000	30,000,000
Coal consumed for year (pounds),	7,122,390	2,413,914
Cost of pumping, figured on pumping station expenses, . . .	\$32,990.07	\$13,622.47
Total pumpage for year, corrected for slip (million gallons), .	18,394.52	2,752.11
Average dynamic head (feet),	49.08	130.92
Gallons pumped per pound of coal,	2,582.63	1,140.10
Duty on basis of plunger displacement,	107,750,000	126,860,000
Cost per million gallons raised to reservoir,	\$1.793	\$4.950
Cost per million gallons raised one foot, . . . . .	.0365	.0378

Consumption.

Estimated total population of the nineteen cities and towns supplied wholly or partially during the year 1910,	1,022,230
Total consumption (gallons), pump basis,	41,539,100,000
Average daily consumption (gallons), pump basis,	113,806,000
Gallons per day to each inhabitant, pump basis,	111.3

Distribution.

	Owned and operated by Metropolitan Water and Sewerage Board.	Total in District supplied by Metropolitan Water Works.
Kinds of pipe used,	- ¹	- ²
Sizes,	60 to 6 inch.	60 to 4 inch.
Extensions, less length abandoned (miles),	4.49	30.75
Length in use (miles),	97.02	1,633.37
Stop gates added,	25	-
Stop gates now in use,	429	-
Service pipes added,	-	3,156
Service pipes now in use,	-	155,636
Meters added,	-	13,389
Meters now in use,	-	58,462
Fire hydrants added,	-	238
Fire hydrants now in use,	-	14,593

¹ Cast-iron and cement-lined wrought iron.
² Cast-iron, cement-lined wrought iron and kalamine.

APPENDIX No. 4.

CONTRACTS MADE AND PENDING DURING

Contracts relating to the

1. Number of Con- tract.	2. WORK.	3. Num- ber of Bids.	AMOUNT OF BID.		6. Contractor.	
			4. Next to Lowest.	5. Lowest.		
1	68	Additions to the pumping plant at Deer Island, Boston Harbor.	4	\$69,230 00 ²	\$51,990 00	Allis-Chalmers Co. Milwaukee, Wis.
2	73	Additions to the pumping plant at East Boston.	1	-	37,000 00 ²	Allis-Chalmers Co., Milwaukee, Wis.
3	74	Extension and repair of engine, boiler and screen-houses and new coal house at East Boston.	6	123,722 00	110,940 00 ²	Woodbury & Leigh- ton Co., Boston.
4	75 ¹	2,950 tons of coal: — 2,500 tons for East Boston pumping station. 450 tons for Alewife Brook pumping station.	6 { 3 {	\$3.96 per ton. \$4.30 per ton.	\$3.69 per ton. ² \$4.25 per ton. ¹	New England Coal and Coke Co., Bos- ton.
5	76 ¹	3,050 tons of coal: — 2,100 tons for Deer Island pumping station. 950 tons for Charlestown pumping station.	7 { 6 {	\$3.85 per ton. \$3.65 per ton.	\$3.74 per ton. ² \$3.64 per ton. ¹	Staples Coal Co., Bos- ton.
6	78 ¹	Additions to the boiler plant at East Boston pumping station.	6	\$31,933 00 ²	\$29,000 00	Robb-Mumford Boiler Co., South Framing- ham.
7	79 ¹	Two sets of screens for the Deer Island pumping station.	2	5,994 00	5,600 00 ¹	Hyde Windlass Co., Bath, Me.
8	80 ¹	Pile wharf, steel floor beams, braces and coal runs at the East Boston pumping station.	8	9,498 00	8,475 00 ²	John T. Scully Founda- tion and Trans- portation Company, Cambridge.
9	82	4,400 tons of coal: — 3,000 tons for East Boston pumping station. 1,000 tons for Charlestown pumping station. 400 tons for Alewife Brook pumping station.	6 { 3 { 2 {	\$4.12 per ton. \$4.09 per ton. \$4.85 per ton.	\$4.10 per ton. ² \$3.90 per ton. ¹ \$4.55 per ton. ¹	New England Coal and Coke Co., Boston.
10	83	2,600 tons of coal for Deer Island pumping station.	3	\$4.22 per ton.	\$4.20 per ton. ²	Metropolitan Coal Co., Boston.

¹ Contract completed.² Contract based upon this bid.

APPENDIX No. 4.

THE YEAR 1910 — SEWERAGE WORKS.

North Metropolitan System.

7. Date of Con- tract.	8. Date of Completion of Work.	9. Prices of Principal Items of Contracts made in 1910.	10. Value of Work done Dec. 31, 1910.	
Nov. 2, 1908	-	-	\$62,307 00	1
June 5, 1909	-	-	18,500 00	2
Aug. 13, 1909	-	-	114,934 71 ^a	3
June 18, 1909	June 1, 1910	-	11,662 77	4
June 25, 1909	June 1, 1910	-	12,442 46	5
Dec. 15, 1909	Dec. 12, 1910	-	31,933 00	6
May 16, 1910	Aug. 20, 1910	For furnishing and delivering two sets of screens for the Deer Island pumping station on the Deer Island wharf in condition for erection.	5,600 00	7
July 15, 1910	Dec. 23, 1910	For furnishing and erecting pile wharf, steel floor beams, braces and coal runs for the East Boston pumping station.	8,618 91	8
July 25, 1910	-	\$4.10 per ton of 2,240 lbs. delivered in bins at East Boston pumping station. \$3.90 per ton of 2,240 lbs. delivered in bins at Charles-town pumping station. \$4.55 per ton of 2,240 lbs. delivered in bins at Alewife Brook pumping station.	9,445 84	9
July 25, 1910	-	\$4.20 per ton of 2,240 lbs. delivered in bins at Deer Island pumping station.	6,238 92	10

^a \$17,284.43 charged to special maintenance fund.

CONTRACTS MADE AND PENDING DURING THE

Contracts relating to the South

1. Number of Con- tract.	2. WORK.	3. Num- ber of Bids.	AMOUNT OF BID.		6. Contractor.	
			4. Next to Lowest.	5. Lowest.		
1	76 ¹	2,500 tons of coal: — 2,100 tons for Ward Street pumping station. 400 tons for Nut Island screen-house.	6 { 7 {	\$4.14 per ton. \$4.10 per ton.	\$4.09 per ton. ² \$3.74 per ton. ²	Staples Coal Co., Bos- ton.
2	77 ¹	400 tons of coal for Quincy pumping station.	3	\$4.40 per ton.	\$4.15 per ton. ²	Neponset River Coal Co., Dorchester.
3	83	500 tons of coal for Nut Island screen-house.	4	\$4.24 per ton.	\$4.20 per ton. ²	Metropolitan Coal Co., Boston.
4	84	2,300 tons of coal for Ward Street pumping station.	3	\$4.45 per ton.	\$4.29 per ton. ²	Staples Coal Co., Bos- ton.
5	85	400 tons of coal for Quincy pumping station.	3	\$4.80 per ton.	\$4.50 per ton. ²	Frost Coal Co., Dor- chester.
6	87	Receiving basin, founda- tions and appurtenances for sewage lift station, Hough's Neck, Quincy.	8	\$10,800 00	\$9,371 00 ¹	John Cashman & Sons Company, Quincy.
7	88	Sewage lift station building, Hough's Neck, Quincy.	6	1,760 00	1,725 00 ²	C. A. Dodge Company, Cambridge.

¹ Contract completed.² Contract based upon this bid.

YEAR 1910 — SEWERAGE WORKS — *Continued.**Metropolitan System.*

7. Date of Con- tract.	8. Date of Completion of Work.	9. Prices of Principal Items of Contracts made in 1910.	10. Value of Work done Dec. 31, 1910.	
June 25, 1909	June 1, 1910	- -	\$8,756 01	1
June 30, 1909	June 1, 1910	- -	1,531 01	2
July 25, 1910	-	\$4.20 per ton of 2,240 lbs. delivered in bins at Nut Island screen-house.	810 00	3
July 25, 1910	-	\$4.29 per ton of 2,240 lbs. delivered in bins at Ward Street pumping station.	1,713 17	4
July 25, 1910	-	\$4.50 per ton of 2,240 lbs. delivered in bins at Quincy pumping station.	299 19	5
Aug. 29, 1910	-	For earth excavation and refilling in receiving basin, pump well, pipe and conduit trenches and grading lot, including manholes, laying of pipe, etc., the sum of \$2,271; for Portland cement brick masonry in manholes, \$16 per cu. yd.; for Portland cement concrete masonry, \$9 per cu. yd.	3,465 50	6
Nov. 14, 1910	-	For brick sewage lift station building, . . .	-	7

CONTRACTS MADE AND PENDING DURING THE YEAR 1910 — SEWERAGE WORKS
— *Concluded.*

Summary of Contracts.¹

	Value of Work done Dec. 31, 1910.
North Metropolitan System, 10 contracts,	\$281,683 61
South Metropolitan System, 7 contracts,	16,574 88
Total of 17 contracts made and pending during the year 1910,	\$298,258 49

¹ In this summary the cost of day work and contracts charged to maintenance are excluded.

APPENDIX NO. 5.

FINANCIAL STATEMENT PRESENTED TO THE GENERAL COURT ON JANUARY 9, 1911.

The Metropolitan Water and Sewerage Board respectfully presents the following abstract of the account of its doings, receipts, expenditures, disbursements, assets and liabilities for the year ending November 30, 1910, in accordance with the provisions of chapter 235 of the Acts of the year 1906.

METROPOLITAN WATER WORKS.

Construction.

The loans authorized for expenditures under the Metropolitan Water acts, the receipts which are added to the loan fund, the expenditures for the construction and acquisition of works, and the balance available on December 1, 1910, have been as follows:—

Loans authorized under Metropolitan Water acts,	\$41,878,000 00	
Receipt from town of Swampscott for admission to Metropolitan Water District, paid into Loan Fund (St. 1909, c. 320),	90,000 00	
Receipts from the sales of property which are placed to the credit of the Metropolitan Water Loan Fund:—		
For the year ending November 30, 1910,	\$8,727 94	
For the period prior to December 1, 1909,	167,051 56	
		175,779 50
		<hr/>
		\$42,143,779 50
Amount approved for payment by the Board out of the Metropolitan Water Loan Fund:—		
For the year ending November 30, 1910,	\$478,791 51	
For the period prior to December 1, 1909,	41,000,955 40	
		41,479,746 91
		<hr/>
Balance December 1, 1910,		\$664,032 59

The amount of the Metropolitan Water Loan bonds issued and outstanding at the beginning of the fiscal year was \$10,898,000. At the end of the year the amount of the loans was \$41,398,000. The Metropolitan Water Loan Sinking Fund amounted at the beginning of the year to \$7,203,406.48, and at the end of the year to \$8,070,383.46. The net decrease in the debt for the Metropolitan Water Works was \$366,976.98.

Maintenance.

Amount appropriated for the maintenance and operation of works for the year ending November 30, 1910,	\$414,000 00	
Balance of special appropriation for the improvement of the Cochituate watershed (1909), remaining,	29,576 10	
Amount appropriated for the improvement of the Cochituate watershed, additional,	6,000 00	
	<hr/>	\$449,576 10
Amount approved by the Board for maintenance and operation of works during year ending November 30, 1910,		408,706 35
		<hr/>
Balance December 1, 1910,		\$40,869 75

This balance includes the sum of \$13,307.38 appropriated for the improvement of the Cochituate watershed, which sum remains for the completion of the improvement.

The Board has also received during the year ending November 30, 1910, \$13,620.20 from rentals, land products and other proceeds from the operations of the Board which, according to section 18 of the Metropolitan Water Act, are applied by the Treasurer of the Commonwealth to the payment of interest on the Metropolitan Water Loan, to sinking fund requirements, and expenses of maintenance and operation of works, thus reducing the amount of the assessment upon the Metropolitan Water District for the year.

Sums received from sales of water to municipalities not belonging to the District and to water companies, and from municipalities for admission to the District, have been applied as follows:—

For the period prior to December 1, 1906, distributed to the cities and towns of the District, as provided by section 3 of the Metropolitan Water Act,	\$219,865 ² / ₆₅
For the period beginning December 1, 1906, and prior to December 1, 1909, applied to the Metropolitan Water Loan Sinking Fund, as provided by chapter 238 of the Acts of 1907,	16,851 21
For the year beginning December 1, 1909, and ending November 30, 1910, applied to the Metropolitan Water Loan Sinking Fund, as provided by said last-named act,	3,798 14
	<hr/>
	\$240,515 00

METROPOLITAN SEWERAGE WORKS.

Construction.

The loans authorized under the various acts of the Legislature for the construction of the Metropolitan Sewerage Works, the receipts which are added to the proceeds of the loans, and the expenditures for construction, are given below, as follows:—

NORTH METROPOLITAN SYSTEM.

Loans authorized for expenditures for construction under the various acts, including those for the Revere, Belmont and Malden extensions and North System enlargement and extension,			\$6,573,865 73
Receipts from sales of real estate and from miscellaneous sources, which are placed to the credit of the North Metropolitan System:—			
For the year ending November 30, 1910,		123 99	
For the period prior to December 1, 1909,		46,307 18	
Amount approved for payment by the Board ¹ out of the Metropolitan Sewerage Loan Fund, North System:—			
For the year ending November 30, 1910,			\$194,897 44
For the period prior to December 1, 1909,			6,303,340 50
			<hr/>
			\$6,620,296 90
			<hr/>
			\$6,498,237 94
			<hr/>
Balance December 1, 1910,			\$122,058 96

SOUTH METROPOLITAN SYSTEM.

Loans authorized for expenditures for construction under the various acts, applied to the construction of the Charles River valley sewer, Neponset valley sewer, High-level sewer and extension,			\$8,867,046 27
Receipts for pumping, sales of real estate and from miscellaneous sources, which are placed to the credit of the South Metropolitan System:—			
For the year ending November 30, 1910,		—	
For the period prior to December 1, 1909,		11,406 82	
Amount approved by the Board for payment as follows:—			
On account of the Charles River valley sewer,			\$800,046 27
On account of the Neponset valley sewer,			911,531 46
On account of the High-level sewer and extension:—			
For the year ending November 30, 1910,			8,570 75
For the period prior to December 1, 1909,			7,071,931 65
			<hr/>
			\$8,878,453 09
			<hr/>
			\$8,792,080 13
			<hr/>
Balance December 1, 1910,			\$86,372 96

The loans for the Metropolitan Sewerage Works outstanding at the beginning of the fiscal year amounted to \$15,327,912, and at the end of the year to \$15,440,912. The amount of the Metropolitan Sewerage Sinking Fund was at the beginning of the fiscal year \$1,672,017.97, and at the end of the year was \$1,929,528.07. The net decrease in the debt for the Metropolitan Sewerage Works was \$144,510.10.

Maintenance.

NORTH METROPOLITAN SYSTEM.

Appropriated for the year ending November 30, 1910,	\$149,000 00
Balance of special appropriation for the restoration and equipment of the East Boston pumping station (1908), remaining,	13,884 43
Receipts from pumping and from other sources, which are returned to the appropriation:—	
For the year ending November 30, 1910,	3,062 79
	<hr/>
	\$165,947 22
Amount approved for payment by the Board:—	
For the year ending November 30, 1910,	159,889 34
	<hr/>
Balance December 1, 1910,	\$6,057 88

¹ The word "Board" refers to the Metropolitan Sewerage Commission and the Metropolitan Water and Sewerage Board.

This balance of \$6,057.88 includes the sum of \$849.43 which still remains out of the special appropriation for the restoration and equipment of the East Boston pumping station, which have not yet been completed. The general balance remaining is consequently \$5,208.45.

SOUTH METROPOLITAN SYSTEM.

Appropriated for the year ending November 30, 1910,	\$103,200 00
Receipts from sales of property and for pumping, which are returned to the appropriation: —	
For the year ending November 30, 1910,	87 65
	<hr/>
	\$103,287 65
Amount approved for payment by the Board: —	
For the year ending November 30, 1910,	100,832 60
	<hr/>
Balance December 1, 1910,	\$2,455 05

APPENDIX No. 6.

LEGISLATION OF THE YEAR 1910 AFFECTING THE METROPOLITAN WATER AND SEWERAGE BOARD.

ACTS OF 1910.

[CHAPTER 32.]

AN ACT RELATIVE TO CERTAIN AUTHORIZED ADDITIONS TO
THE METROPOLITAN WATER LOAN.

Be it enacted, etc., as follows:

SECTION 1. Section two of chapter three hundred and twenty of the acts of the year nineteen hundred and nine, being "An Act to authorize the metropolitan water and sewerage board to make certain improvements in the metropolitan water system", is hereby amended by striking out the words and figures "Act of 1909", in the thirteenth line.

1909, 320, § 2.
amended.

SECTION 2. This act shall take effect upon its passage.
[Approved January 31, 1910.]

[CHAPTER 220.]

AN ACT TO PROVIDE FOR SUPERVISION BY THE GOVERNOR AND
COUNCIL OF EXPENDITURES AND OTHER FINANCIAL OPERATIONS OF THE COMMONWEALTH.

Be it enacted, etc., as follows:

SECTION 1. Every officer or board having charge of any department, institution or undertaking which receives an annual appropriation of money from the treasury of the commonwealth, including annual appropriations to be met by assessments, shall, annually, on or before the fifteenth day of November, submit to the auditor of the commonwealth statements in detail showing the amount appropriated for the current fiscal year and the amounts required for the ensuing fiscal year, with an explanation of the reason for any in-

Requests for annual appropriations to be submitted to auditor and transmitted to governor and council.

creased appropriation, and with citations of the statutes relating thereto, and with a statement of the expenditures for the current year and for each of the next preceding two years. The said estimates shall not include any estimates for special purposes or objects. The auditor of the commonwealth shall embody the said statements, with a like statement relating to his own department, in one document, which shall be printed, and shall be submitted on or before the first Thursday in January of each year to the governor and council for examination, and the governor shall transmit the same to the general court with such recommendations, if any, as he may deem proper. The auditor shall also submit his estimates for the ensuing fiscal year for the ordinary and other revenue of the commonwealth which shall be made a part of the document herein provided for. Copies of the document shall be distributed to the members of the general court.

Requests for special appropriations to be submitted to auditor and transmitted to governor and council.

SECTION 2. Officers, heads of departments, boards, commissions and trustees of institutions, who, in their annual reports, or otherwise, recommend appropriations from the state treasury for special purposes or objects, including appropriations to be met by assessments, in addition to the ordinary running expenses, shall submit estimates thereof in detail to the auditor of the commonwealth on or before the fifteenth day of November in each year, and he shall classify them and embody them in one document which shall be printed, and shall be submitted on or before the first Thursday in January of each year to the governor and council for examination, and the governor shall transmit the same to the general court with such recommendations, if any, as he may deem proper. He shall make recommendation as to how much should be raised by the issue of bonds and how much should be paid out of current revenue. Copies of the document shall be distributed to the members of the general court.

Plans, estimates, etc., to be submitted to governor and council.

SECTION 3. The plans, estimates and specifications made in accordance with the provisions of chapter five hundred and twenty of the acts of the year nineteen hundred and seven, or of amendments thereof, relating to any improvement described in either of the documents aforesaid, shall at the same time be submitted to the governor and council.

Further information to be furnished by auditor.

SECTION 4. The auditor shall furnish to the governor and council such further information in regard to the revenue,

expenditures and other financial operations of the commonwealth, and in such form as the governor may require.

SECTION 5. The governor may, in his discretion, transmit to the general court from time to time, with his recommendations, if any, thereon, particular items in either of the said documents, and may withhold other items for further investigation.

Recommendations of the governor to general court.

SECTION 6. Section twenty-six of chapter six of the Revised Laws, as amended by section six of chapter two hundred and eleven of the acts of the year nineteen hundred and five and section five of chapter five hundred and ninety-seven of the acts of the year nineteen hundred and eight, and all acts and parts of acts inconsistent herewith, are hereby repealed.

Repeal.

SECTION 7. This act shall take effect upon its passage.
[Approved March 16, 1910.]

[CHAPTER 268.]

AN ACT TO PROVIDE FOR THE ANNUAL PREPARATION AND
PRINTING OF LISTS OF STATE OFFICIALS AND EMPLOYEES
WITH THEIR SALARIES OR COMPENSATION.

Be it enacted, etc., as follows:

SECTION 1. Every department, commission, bureau or board of the commonwealth, shall, on or before the fifteenth day of July in the year nineteen hundred and ten, and on or before the fifteenth day of July in every year thereafter, prepare and furnish to the governor and council lists of all the officials and employees of the commonwealth employed in or by such department, commission, bureau or board on the first day of July preceding, for whose services money has been paid from the treasury of the commonwealth. The said lists shall be arranged by divisions of the several departments, commissions, bureaus or boards, when such divisions exist, and shall give the name, residence, designation, rate of compensation and the date of election or appointment of every such official and employee, and any increase in the rate of salary or compensation for the year preceding; and also the aggregate amount of all money paid for services or salaries to any official or employee, not otherwise shown upon the list, for the year beginning with the first day of July in the year

Lists of officials and employees of the commonwealth to be furnished to the governor and council, etc.

Auditor to
verify lists,
etc.

preceding that in which the list is prepared. It shall be the duty of the auditor of the commonwealth to verify the said lists, the compensation and the said aggregate amounts from the pay roll. The said lists and aggregate amounts shall be printed at the expense of the commonwealth as a document of the commonwealth, before the first day of October in the year in which they are furnished, and the said document shall contain the complete data and facts called for by this act.

SECTION 2. This act shall take effect upon its passage.
[Approved March 22, 1910.]

[CHAPTER 291.]

AN ACT TO AUTHORIZE THE METROPOLITAN WATER AND SEWERAGE BOARD TO MAKE CERTAIN IMPROVEMENTS IN THE METROPOLITAN WATER SYSTEM.

Be it enacted, etc., as follows:

Appropriations for construction for certain purposes in metropolitan water district.

SECTION 1. The sum of one hundred and five thousand dollars shall be allowed and paid out of the treasury of the commonwealth from the Metropolitan Water Loan Fund for the following purposes:— For a thirty-six inch main for the improvement of the supply of the East Boston district of the city of Boston; and for a new main for the extension of the high-service district in Arlington and Lexington.

Issue of bonds authorized.

SECTION 2. For the purposes aforesaid the metropolitan water and sewerage board may, in addition to providing for the improvements for which expenditures have hitherto been authorized, expend any sum heretofore appropriated for the construction of the metropolitan water works. To meet the further expenditures incurred under the provisions of this act, and not so provided for, the treasurer and receiver general shall, from time to time, issue upon the request of said board, bonds in the name and behalf of the commonwealth, to be designated on the face thereof, Metropolitan Water Loan, to an amount not exceeding eighty thousand dollars, in addition to the sum of forty-one million seven hundred and ninety-eight thousand dollars authorized to be issued by chapter four hundred and eighty-eight of the acts of the year eighteen hundred and ninety-five and acts in addition thereto, and the provisions of said chapter four hundred and eighty-

eight and acts in amendment thereof and in addition thereto shall apply to this additional loan.

SECTION 3. This act shall take effect upon its passage.
[Approved March 25, 1910.]

[CHAPTER 292.]

AN ACT TO AUTHORIZE THE METROPOLITAN WATER AND SEWERAGE BOARD TO ENABLE THE CITY OF QUINCY TO DRAIN ITS TERRITORY INTO THE HIGH-LEVEL SEWER.

Be it enacted, etc., as follows:

SECTION 1. The metropolitan water and sewerage board is hereby authorized to expend from the balance remaining of the Metropolitan Sewerage Loan Fund, South System, such sum as may be required in compliance with section eight of chapter four hundred and twenty-four of the acts of the year eighteen hundred and ninety-nine for the construction of such works as may be necessary in order to enable the city of Quincy to drain by gravity its territory into the high-level sewer.

The city of Quincy may drain its territory into the high-level sewer.

SECTION 2. This act shall take effect upon its passage.
[Approved March 25, 1910.]

[CHAPTER 340.]

AN ACT MAKING AN APPROPRIATION FOR OPERATING THE SOUTH METROPOLITAN SYSTEM OF SEWAGE DISPOSAL.

Be it enacted, etc., as follows:

SECTION 1. A sum not exceeding one hundred and three thousand two hundred dollars is hereby appropriated, to be paid out of the South Metropolitan System Maintenance Fund, for the cost of maintenance and operation of the south metropolitan system of sewage disposal, comprising a part of Boston, the cities of Newton and Waltham, and the towns of Brookline, Watertown, Dedham, Hyde Park and Milton, during the fiscal year ending on the thirtieth day of November, nineteen hundred and ten.

Appropriation for maintenance of south metropolitan sewerage system.

SECTION 2. This act shall take effect upon its passage.
[Approved April 2, 1910.]

[CHAPTER 341.]

AN ACT MAKING AN APPROPRIATION FOR OPERATING THE
METROPOLITAN WATER SYSTEM.*Be it enacted, etc., as follows:*

Appropriation
for maintenance
of
metropolitan
water works.

SECTION 1. A sum not exceeding four hundred and twenty thousand dollars is hereby appropriated, to be paid out of the Metropolitan Water Maintenance Fund, for the maintenance and operation of the metropolitan water system for the cities and towns in what is known as the metropolitan water district, during the fiscal year ending on the thirtieth day of November, nineteen hundred and ten.

SECTION 2. This act shall take effect upon its passage.
[Approved April 2, 1910.]

[CHAPTER 359.]

AN ACT RELATIVE TO APPOINTMENT AND EMPLOYMENT IN
THE PUBLIC SERVICE IN VIOLATION OF THE CIVIL SERVICE
LAW OR RULES.*Be it enacted, etc., as follows:*

R. L. 19, § 34,
amended.

Enforcement
of civil service
rules.

Chapter nineteen of the Revised Laws is hereby amended by striking out section thirty-four and inserting in place thereof the following:— *Section 34.* If, in the opinion of the civil service commission, a person is appointed or employed in the public service classified under civil service rules, in violation of the civil service law, or of the said rules, the commission shall, after written notice mailed to the appointing or employing officer or officers, and to such person, notify in writing the treasurer, auditor or other disbursing officer of the commonwealth, city or town, in whose service or by which such person is so employed or paid; and the payment of any salary or compensation to such person shall be illegal and shall cease at the expiration of one week after the mailing of the latter notice, and until the legality of such appointment or employment is duly established. It shall be unlawful for the treasurer, auditor or other disbursing officer of the commonwealth, or of such city or town to draw, sign or issue, or to authorize the drawing, signing or issuing of any warrant, or to make payment of any salary or compensation

to the person so found by the civil service commission to be illegally appointed or employed. Any person so found by the civil service commission to be illegally appointed or employed may file a petition for a writ of mandamus in the superior or supreme judicial court to compel the civil service commission to authorize such appointment, or employment, and the payment of compensation or salary therefor. At any time after the filing of such petition the court, if it is of opinion that there is reasonable doubt whether the appointment or employment of such person is in violation of the civil service law or rules, may order that the compensation accruing to such person shall be paid to him until otherwise ordered by said court. [*Approved April 8, 1910.*]

Petition for writ of mandamus may be filed, etc.

[CHAPTER 388.]

AN ACT MAKING AN APPROPRIATION FOR OPERATING THE NORTH METROPOLITAN SYSTEM OF SEWAGE DISPOSAL.

Be it enacted, etc., as follows:

SECTION 1. A sum not exceeding one hundred and forty-nine thousand dollars is hereby appropriated, to be paid out of the North Metropolitan System Maintenance Fund, for the maintenance and operation of the system of sewage disposal for the cities included in what is known as the north metropolitan system, during the fiscal year ending on the thirtieth day of November, nineteen hundred and ten.

Appropriation for maintenance of north metropolitan sewerage system.

SECTION 2. This act shall take effect upon its passage. [*Approved April 13, 1910.*]

[CHAPTER 452.]

AN ACT RELATIVE TO THE RECOMMENDATIONS FOR LEGISLATION IN THE ANNUAL REPORTS OF STATE BOARDS AND COMMISSIONS.

Be it enacted, etc., as follows:

SECTION 1. Section six of chapter eighteen of the Revised Laws is hereby amended by inserting after the word "action", in the sixth line, the words: — such recommendations or suggestions to be accompanied by drafts of bills

R. L. 18, § 6, amended.

Recommendations for legislation, etc.

embodying the legislation recommended, — so as to read as follows:— *Section 6.* State boards and commissions shall annually, on or before the first Wednesday in January, deposit with the secretary of the commonwealth such parts of their annual reports which are required to be made to the governor and council or to the general court as contain recommendations or suggestions for legislative action, such recommendations or suggestions to be accompanied by drafts of bills embodying the legislation recommended; and the secretary shall forthwith transmit them to the governor and council or to the general court.

SECTION 2. This act shall take effect upon its passage.
[Approved April 27, 1910.]

[CHAPTER 500.]

AN ACT RELATIVE TO HEARINGS GIVEN TO VETERANS IN THE
PUBLIC SERVICE.

Be it enacted, etc., as follows:

R. L. 19,
§ 23, etc.,
amended.

Veterans not
to be removed
without a
hearing, etc.

SECTION 1. Section twenty-three of chapter nineteen of the Revised Laws, as amended by chapter one hundred and fifty of the acts of the year nineteen hundred and five, is hereby further amended by striking out the said section and inserting in place thereof the following:— *Section 23.* No veteran who holds an office or employment in the public service of the commonwealth or of any city or town therein, shall be removed or suspended, or shall, without his consent, be transferred from such office or employment, nor shall his office be abolished, nor shall he be lowered in rank or compensation, except after a full hearing of which he shall have at least seventy-two hours' written notice, with a statement of the reasons for the contemplated removal, suspension, transfer, lowering in rank or compensation, or abolition. The hearing shall be before the state board of conciliation and arbitration, if the veteran is a state employee, and before the selectmen of the town of which he is an employee, if the veteran is a town employee. If the veteran is a city employee the hearing shall be held before the board of aldermen of the city of which the veteran is an employee. In case the city of which the veteran is an employee has not a board of aldermen, the hearing shall be held before the city council of such city. At any hearing

where the veteran is a party in interest, he shall have the right to be present and to be represented by counsel. The said removal, suspension or transfer, lowering in rank or compensation, or abolition of an office, shall be made only upon a written order stating fully and specifically the cause or causes therefor, and signed by the state board of conciliation and arbitration, or selectmen, or said members of the city government, as the case may be, after a hearing as aforesaid.

SECTION 2. This act shall take effect upon its passage.

(The foregoing was laid before the Governor on the third day of May, 1910, and after five days it had "the force of a law", as prescribed by the Constitution, as it was not returned by him with his objections thereto within that time.)

[CHAPTER 515.]

AN ACT RELATIVE TO THE TAXATION OF PROPERTY HELD BY THE METROPOLITAN WATER AND SEWERAGE BOARD IN THE TOWN OF CLINTON AND TO THE SALE OR DISPOSAL OF ELECTRICITY BY SAID BOARD.

Be it enacted, etc., as follows:

SECTION 1. The property held by the metropolitan water and sewerage board, or its successors, in the town of Clinton which may be subject to taxation under the provisions of section two of chapter four hundred and ninety-eight of the acts of the year nineteen hundred and six shall be assessed on a valuation of one hundred and twenty-five thousand dollars in any year in which any power is generated and sold.

Taxation of property held by metropolitan water and sewerage board in town of Clinton.

SECTION 2. In the sale or disposal of electricity generated in the town of Clinton for power or manufacturing purposes under the provisions of section three of chapter four hundred and eighty-eight of the acts of the year eighteen hundred and ninety-five, preference shall be given to persons or corporations proposing to use all of such electricity in the town of Clinton: *provided*, that there are responsible persons or corporations so proposing to use all the electricity in said town who shall offer to purchase the same on terms as advantageous as shall be offered by others not so proposing to use the same; and the said board shall, at least ten days before making a contract for the sale of such electricity, cause to be printed in some newspaper published in said town a request for pro-

Sale or disposal of electricity.

Proviso.

posals for the purchase of the electricity to be generated and sold by said board.

SECTION 3. This act shall take effect upon its passage.
[Approved May 13, 1910.]

[CHAPTER 546.]

AN ACT TO PROVIDE FOR THE ADDITION OF THE TOWN OF
BRAINTREE TO THE SOUTH METROPOLITAN SEWERAGE
SYSTEM.

Be it enacted, etc., as follows:

SECTION 1. The territory comprising the town of Braintree is hereby added to the south metropolitan sewerage district, created by chapter four hundred and twenty-four of the acts of the year eighteen hundred and ninety-nine. In becoming a part of the said system said town shall be subject to the provisions and shall conform to the requirements of said act and acts in amendment thereof and in addition thereto, except as is otherwise provided herein. Any authority granted to other municipalities by said act or acts in amendment thereof and in addition thereto is also vested in the town of Braintree, in common with such other municipalities.

SECTION 2. The metropolitan water and sewerage board shall provide an outlet at the Braintree town line for the sewerage of said town, and, acting on behalf of the commonwealth, shall construct a main trunk sewer or sewers through such parts of the city of Quincy to such point in the south metropolitan system as said board may determine to be necessary in order to make connection with the high-level sewer.

SECTION 3. In providing for such outlet and in receiving sewage from the town of Braintree, and in any action relating thereto, and for the purpose of taking, constructing and maintaining such additional main lines of sewers, the said metropolitan water and sewerage board, acting on behalf of the commonwealth, shall have and exercise all the authority conferred upon it by chapter four hundred and thirty-nine of the acts of the year eighteen hundred and eighty-nine and by chapter one hundred and sixty-eight of the acts of the year nineteen hundred and one, and by acts in amendment thereof and in addition thereto; and all the provisions of said acts are made applicable to the additional construction, mainte-

Town of
Braintree
added to the
south metro-
politan
sewerage
district.

Outlet to be
provided at
the Braintree
town line, etc.

The metro-
politan water
and sewerage
board to
exercise certain
authority, etc.

nance and operation hereby authorized except as otherwise provided herein.

SECTION 4. To meet the expenses incurred under the provisions of this act, the treasurer of the commonwealth shall from time to time issue in the name and behalf of the commonwealth and under its seal bonds designated on the face thereof, Metropolitan Sewerage Loan, for a term not exceeding thirty years, to an amount not exceeding one hundred thousand dollars in addition to the amount of such bonds heretofore authorized for the construction of the south metropolitan sewerage works. The provisions of chapter four hundred and twenty-four of the acts of the year eighteen hundred and ninety-nine and all acts in amendment thereof and in addition thereto shall, so far as they are applicable, apply to the indebtedness authorized by this act.

Metropolitan
Sewerage
Loan.

Certain
provisions of
law to apply.

SECTION 5. The interest and sinking fund requirements on account of the moneys expended in constructing that part of the sewerage system provided for in this act, and the cost of maintenance and operation thereof, shall be deemed and paid as a part of the interest, sinking fund requirements and costs specified in said chapter four hundred and twenty-four of the acts of the year eighteen hundred and ninety-nine and acts in amendment thereof and in addition thereto, and shall be apportioned, assessed and collected in the manner provided by that chapter and acts in amendment thereof and in addition thereto except as is otherwise provided herein. The town of Braintree shall, in addition to the yearly payment of the assessment so provided for, pay into the treasury of the commonwealth for the sinking fund of the south metropolitan sewerage district such proportion of the total amount of said sinking fund, as existing on the first day of May in the year of its admission to the south metropolitan district, as the valuation of the said town for the said year shall bear to the total amount of the valuation of said district, as determined for the purposes of apportionment of assessments; and the town shall also pay the further sum of one thousand dollars. Such proportion shall be determined by the metropolitan water and sewerage board and shall be certified by said board to the treasurer of the commonwealth. The treasurer shall determine the total amount so to be paid by said town on account of its admission to the district, and for

Payment of
loans, etc.

the payment thereof shall add one fifth of said total amount to the yearly sum payable by said town on account of its share of the interest and sinking fund requirements of the district for the succeeding five years. No assessment on account of maintenance requirements of the south metropolitan sewerage district shall be made upon said town until the calendar year in which its sewers shall be connected with the south metropolitan system as herein provided.

Time of taking effect.

SECTION 6. This act shall take effect when accepted by vote of the majority of the legal voters of the town of Braintree present and voting thereon at a meeting legally called for the purpose. [Approved May 23, 1910.]

[CHAPTER 547.]

AN ACT TO PROVIDE FOR AN OUTLET FOR THE SEWAGE OF THE CITIES OF MALDEN AND EVERETT INTO THE NORTH METROPOLITAN SEWERAGE SYSTEM.

Be it enacted, etc., as follows:

Additional outlet for the sewage of Malden and Everett to be provided.

SECTION 1. The metropolitan water and sewerage board may, in order to provide an additional outlet for the sewage of the cities of Malden and Everett, acting in behalf of the commonwealth, take, or acquire by purchase or otherwise, the existing sewer belonging to the city of Malden from a point at or near the corner of Eastern avenue and Bryant street in said city and running northerly through Eastern avenue to a point at or near the middle of Broadway; and the said board is hereby authorized to pay to the city of Malden the actual cost of the construction of the portion of the sewer so taken, less such assessments as have been collected prior to the date of such taking. The said portion of the sewer when so taken shall become a part of the north metropolitan system of sewers. Upon acquiring the portion of the sewer in Eastern avenue as aforesaid the said board shall proceed to construct a sewer extending from said sewer through Broadway to a point at or near the boundary line between the cities of Malden and Everett, and the sewer so constructed shall become a part of the north metropolitan system. The city of Everett may, under the direction of said board, connect its local system of sewers with said metropolitan sewer

in Broadway. The city of Malden may, under the direction of said board, connect its local system of sewers with the said metropolitan sewers in Broadway and Eastern avenue and may also, subject to such direction, make and maintain house connections with the said sewer. The city of Malden shall make assessments of annual rates for said metropolitan sewers in Broadway and Eastern avenue in the same manner in which such assessments are now made in said city for its local sewers. All such sums as may be assessed therefor shall be paid by the treasurer of said city into the treasury of the commonwealth, except such assessments as may be collected upon the portion of said sewer in Eastern avenue between Faulkner and Bryant streets, and shall be credited to and become a part of the Metropolitan Sewerage Loan Fund authorized by chapter four hundred and thirty-nine of the acts of the year eighteen hundred and eighty-nine and acts in amendment thereof and in addition thereto.

SECTION 2. For the purpose of taking and constructing said metropolitan sewers in Eastern avenue and Broadway and for the operation and maintenance thereof, the said board, acting in behalf of the commonwealth, shall have and exercise all the authority conferred upon it by chapter four hundred and thirty-nine of the acts of the year eighteen hundred and eighty-nine and all acts in amendment thereof and in addition thereto, and all the provisions of said acts are made applicable to the taking, construction, maintenance and operation of said sewers except as is otherwise provided herein.

The metropolitan water and sewerage board to exercise certain authority, etc.

SECTION 3. To meet the expenses incurred under the provisions of this act the treasurer and receiver general shall, from time to time, issue in the name and behalf of the commonwealth and under its seal bonds designated on the face thereof Metropolitan Sewerage Loan, for a term not exceeding thirty years, to an amount not exceeding fifty-six thousand dollars, in addition to the amount of such bonds heretofore authorized for the construction of the north metropolitan sewerage works. The provisions of chapter four hundred and thirty-nine of the acts of the year eighteen hundred and eighty-nine and of chapter four hundred and twenty-four of the acts of the year eighteen hundred and ninety-eight and

Metropolitan Sewerage Loan.

Certain provisions of law to apply.

all acts in amendment thereof and in addition thereto shall, so far as they may be applicable, apply to the indebtedness authorized by this act.

Payment of
loans, etc.

SECTION 4. The treasurer and receiver general shall, in addition to levying the assessments now required by law to meet the interest and sinking fund requirements of the north metropolitan system, assess annually upon the cities of Malden and Everett, in equal shares, such sums as may be necessary to satisfy the interest and sinking fund requirements of the bonds issued under the provisions of this act.

SECTION 5. This act shall take effect upon its passage.
[Approved May 23, 1910.]

[CHAPTER 550.]

AN ACT RELATIVE TO THE POLLUTION OF CERTAIN SOURCES
OF WATER SUPPLY.

Be it enacted, etc., as follows:

R. L. 75, § 123,
amended.

Section one hundred and twenty-three of chapter seventy-five of the Revised Laws is hereby amended by striking out the said section and inserting in place thereof the following: — *Section 123.* The provisions of the preceding eleven sections shall not apply to the Connecticut river. The provisions of the preceding five sections and of so much of sections one hundred and twelve to one hundred and seventeen, inclusive, as refers to domestic water supplies shall not apply to the Merrimac river, nor to so much of the Concord river as lies within the limits of the city of Lowell, nor to springs, streams, ponds or water courses over which the metropolitan water and sewerage board has control. [Approved May 23, 1910.]

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N.

NORTH METROPOLITAN SEWERAGE SYSTEM.

appropriation for maintenance of,	388	1
to provide an additional outlet for the sewage of Malden and Everett into,	547	1

Q.

QUINCY.

may drain its territory into High-level Sewer,	292	1
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S.

SOUTH METROPOLITAN SEWERAGE SYSTEM.

appropriation for maintenance of,	340	1
Quincy may drain its territory into,	292	1
town of Braintree included in,	546	1

T.

TAXATION.

of property held for water supply in Clinton,	Chap. 515	Sect. 1
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V.

VETERANS.

in public service, relative to hearings to,	500	1
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W.

WATER SUPPLY.

relative to pollution of certain sources of,	550	1
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